Final Environmental Impact Statement

Northern San Juan Basin Coal Bed Methane Project
Volume I

U.S. Department of Interior
Bureau of Land Management
San Juan Field Office

U.S. Department of Agriculture
Forest Service
San Juan National Forest

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MISSION STATEMENT

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Dear Reader:

Enclosed please find the Final Northern San Juan Basin Coal Bed Methane (CBM) Project Environmental Impact Statement (FEIS) for your review and information as the last step before final project decisions are made. The FEIS analyzes the environmental effects of proposals made by six energy companies to develop natural gas wells on previously leased federal minerals within a 125,000-acre study area in La Plata and Archuleta counties. The study area includes the portion of the San Juan Basin located north of the Southern Ute Indian Reservation. The proponents also provided plans for development of private lands and minerals in the study area. No federal decision will be made on private mineral development, but the information has been included in the FEIS for cumulative-impact analysis purposes.

How We've Used Your Input

This FEIS is based on the analysis presented in the Draft Northern San Juan Basin CBM Project Environmental Impact Statement (DEIS), public input provided on the DEIS, and on new information that has become available. We received a tremendous amount of public input on the DEIS, including almost 68,000 comments submitted during the nearly six-month comment period, or voiced during our many public forums. This public input has had a huge effect on our overall analysis of the project. The most significant change reflected in the FEIS is the addition and analysis of two new alternatives. These new alternatives are presented at Chapter 2.2. Other key changes made in response to your comments include:

- Revised mitigation measures for water, vegetation, safety and private property impacts under Section 3.3 - Migration and Seepage of Methane,
- Updated spring locations, watershed impact analyses, and mitigation measures under Sections 3.5 and 3.6 - Surface and Groundwater, and
- Revised appendices presenting requirements for financial guarantees (Appendix A, Surface Use Requirements), an updated report on alternative drilling technologies (Appendix D), examples for mitigation of outcrop impacts (Appendix N), and our responses to public comments (Appendix O).

New Preferred Alternative

FEIS Alternative 7, our new Preferred Alternative, was developed in response to your comments and concerns. Among the most prominent of concerns was the locating of new roads and gas-development facilities in the HD Mountains; specifically with authorizing surface facilities in areas of steep, unstable slopes and with other environmental concerns including water, air, cultural resources, wildlife habitat, and old-growth ponderosa pine forests. We also heard we should avoid prescribing drilling technologies, while at the same time, we should not assume conventional drilling approaches were the only option. Comments highlighted apparent cause-and-effect relationships between CBM development and Outcrop impacts, noting these relationships may not be fully understood at this time. Many comments asked for a more thorough examination of potential mitigation measures and suggested we require adequate financial assurances before development begins, especially in sensitive areas. Finally, comments from project proponents and others clearly stated concerns with arbitrarily conditioning existing leases with new restrictions.

Alternative 7 best balances valid existing gas development lease rights with legitimate social and environmental issues. This, our Preferred Alternative, would not allow development of CBM facilities or ac-

cess across unstable areas, as proposed, in the HD Mountains south of the Relay Tower Road, south of the Rock Bridge, and in Ignacio Creek. Alternative 7 would require geologic, hydrologic and gas-reservoir information to be obtained from individual, or small groups of, test wells in less sensitive areas before development would be considered in more sensitive areas within the 1½-mile Outcrop buffer zone. This systematic approach would include intensive monitoring to better characterize the hydrogeology of the Fruitland Formation and detect potential impacts before they manifest at the Outcrop. It also would require mitigation measures to address potential adverse impacts to water, vegetation, safety, and private property.

Many of you, including the La Plata and Archuleta County Commissioners, Town Councils of Bayfield and Ignacio, and City of Durango, requested we not permit surface facilities in the HD Mountains Roadless Area or within the 1½-mile Outcrop buffer zone. We developed Alternative 6 in response to these comments, but were not able to select this as our preferred alternative, because denying all surface occupancy or prescribing drilling technologies would be inconsistent with lease rights, and because such action is not supported by the findings of potential impacts. Similarly, to simply deny development everywhere within the Outcrop buffer zone is not consistent with the current body of information and analyses. Although Alternative 6 is not our preferred alternative, it does help frame the overall analysis of potential environmental effects, alternative drilling technologies, and the tradeoffs involved should no surface facilities be authorized within the HD Mountains Roadless Area and no drilling be authorized within the Outcrop buffer zone.

Next Steps
The FEIS will be available for at least 30 days after the date the Environmental Protection Agency publishes its Notice of Availability in the *Federal Register* before any final project determinations will be made in a Record of Decision (ROD). The ROD, when issued, will document BLM and FS project decisions described in FEIS Section 1.4. The ROD will also document mitigation measures that will be applied to the selected alternative. If you feel there is new information which was not included in the FEIS or is relevant to project decision making, send it by mail to the San Juan Public Lands Center, 15 Burnett Court, Durango, CO 81301, Attn: Walt Brown, or by Email to: nsjb-feis@arcadis-us.com by September 5, 2006.

The FEIS is on-line at http://www.nsjb-eis.net, or http://www.fs.fed.us/r2/sanjuan/projects/projects.shtml. Hard copies of the FEIS are available for review at the San Juan Public Lands Center, 15 Burnett Court, Durango, Colorado 81301, or the Columbine Ranger District and Field Office, 367 Pearl Street, Bayfield Colorado 81122.

There is no doubt that the San Juan Basin is an important source of natural gas, and will be for some time. It is obvious, however, that drilling for these resources, particularly in the areas of the HD Mountains and Fruitland Outcrop, poses some very significant social and environmental concerns. I believe this EIS process, especially our analysis of, and response to, the great volume of comments and additional information provided, has led to a very thorough consideration of the proposed action and alternatives, potential environmental effects, opportunities to avoid or mitigate impacts, and potential social, economic and environmental tradeoffs. We greatly appreciate your interest, effort, and passion in assisting us in completing this analysis.

Sincerely,

Mark W. Stiles

Mark W. Stiles
Forest Supervisor/Center Manager

Final Environmental Impact Statement
Northern San Juan Basin Coal Bed Methane Project
La Plata and Archuleta Counties

Lead Agencies: U.S. Forest Service and Bureau of Land Management
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Abstract

Six companies have proposed to drill 185 CBM wells on federal mineral estate and a total of 284 new CBM wells within the Project Area. The companies would also construct the ancillary facilities needed to support these wells. These facilities include access roads; pipelines for gathering gas and produced water; electric facilities; facilities for measuring and compressing gas; and facilities for treating, containing, and disposing of produced water using deep underground injection. The companies' proposal includes directional drilling to avoid steep slopes in portions of the HD Mountains, where feasible.

The overall life of the project, including construction, production, and initiation of reclamation, would be approximately 40 years. Construction of wells would begin during 2006 and would continue for approximately 5 years. The productive life of each well is expected to be about 25 to 30 years. Accordingly, production from the wells drilled at the end of the 5-year drilling period is expected to conclude by 2040. This environmental analysis of the companies' proposal to develop the gas field focuses on a 125,000-acre Project Area in the Northern San Juan Basin of Colorado. The Project Area occupies portions of La Plata and Archuleta Counties.

Five alternatives are analyzed in detail in the FEIS. Thematically, they represent the Proposed Action (Alternative 1), Maximum Development (Alternative 2), BLM and FS modifications of the Proposed Action (Alternatives 6 and 7), and the No Action Alternative (Alternative 5). Alternative 7 is the BLM and Forest Service Preferred Alternative. Each of the alternatives considers the federal action, which is development of federal oil and gas leases within the Project Area, and also development on other jurisdictions, including private and state leases within the Project Area.

The Forest Supervisor/Center Manager (Mark W. Stiles) is the Authorized Officer responsible for preparing this final Environmental Impact Statement.

Preface

This Environmental Impact Statement (EIS) follows the format established in the National Environmental Policy Act's regulations (Title 40 Code of Federal Regulations Parts 1500 to 1508). The following is an outline of information contained in the chapters and appendices so readers may find the areas of interest without having to scan the entire document.

- *Chapter 1 — Purpose and Need,* identifies and describes the purpose of and need for the proposed action, the history of oil and gas development in the Northern San Juan Basin, decisions to be made by the agencies, their roles and responsibilities, the National Environmental Policy Act (NEPA) process, and other permits required. This chapter also describes the processes for public participation and issue identification.

- *Chapter 2 — Proposed Action and Alternatives* describes the proposed action and the key issues associated with the proposed action, and alternatives, including the no action alternative. The agencies developed action alternatives that meet the purpose of and need for the project in response to one or more of the key issues. Alternatives considered but eliminated from detailed consideration are identified, along with the rationale for excluding them from the analysis. This chapter also provides a comparative analysis of the environmental effects of the alternatives to provide a clear basis of choice among options for the decision maker and the public. The agency preferred alternative is identified.

- *Chapter 3 — Affected Environment and Environmental Consequences* scribes the present condition of the environment that would be affected by implementation of the proposed action or any action alternative. The Environmental Consequences describes the probable and cumulative effects to the human environment that would result from implementing the proposed action or alternatives. The discussion also addresses unavoidable impacts, and irreversible or irretrievable impacts. Activities that contribute to cumulative effects that are reasonably foreseeable are also identified and analyzed in concert with the alternatives.

- *Chapter 4 — Consultation with Others*: identifies the agencies, companies, and organizations consulted, as well as the cooperating agencies.

- *Chapter 5— Preparers and Contributors*: identifies the staff involved in final EIS preparation.

- *Chapter 6 — Distribution of the final EIS*: identifies the persons, organizations, businesses, and agencies that received the draft EIS.

- *Chapter 7 — Glossary*: describes the technical terms used in the final EIS.

- *Chapter 8 — References Cited*: lists the references cited in the final EIS.

- *Appendices*: contain technical and non-technical information that is important to full review of the NEPA analysis but that was too long to be included in the primary chapters.

Acronyms and Abbreviations used in this EIS

°C	Degrees Celsius
°F	Degrees Fahrenheit
μeq/L	Milliequivalents per liter
μg/L	Micrograms per liter
μg/m^3	Micrograms per cubic meter
μmhos/cm	Micromhos per centimeter
AADT	Annual Average Daily Traffic
ACEC	Area of Critical Environmental Concern
ADT	Average Daily Traffic
AHA	Applied Hydrology Associates, Inc.
AIRFA	American Indian Religious Freedom Act
ANC	Acid Neutralizing Capacity
APD	Application for Permit to Drill
APE	Area of Potential Effect
API	American Petroleum Institute
APLIC	Avian Power Line Interaction Committee
AQD	Air Quality Division
AQRV	Air Quality Related Values
ASME	American Society of Mechanical Engineers
ATV	All-terrain Vehicle
AUM	Animal Unit Month
BA	Biological Assessment
BACT	Best Available Control Technology
BAER	Burned Area Emergency Response Team
bcf	Billion Cubic Feet
BE	Biological Evaluation
BLM	U.S. Department of Interior, Bureau of Land Management
BMP	Best Management Practices
BOPE	Blowout Prevention Equipment
BOR	U.S. Bureau of Reclamation
BTS	Bureau of Transportation Statistics
BTU	British Thermal Unit
CAA	Clean Air Act
CALMET	California Meteorological Model
CALPUFF	California Puff atmospheric dispersion model
CBM	Coal Bed Methane
CCC	Civilian Conservation Corps
CDMG	Colorado Division of Minerals and Geology
CDOLA	Colorado Department of Local Affairs
CDOLE	Colorado Department of Labor and Employment
CDOT	Colorado Department of Transportation
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CDPHE-APCD	Colorado Department of Public Health and Environment, Air Pollution Control Division
CDWR	Colorado Department of Water Resources
CEAA	Cumulative Effects Analysis Area
CEQ	Council on Environmental Quality

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CGS	Colorado Geological Survey
CIR	County Impact Report
CO	Carbon Monoxide
COA	Conditions of Approval
COGCC	Colorado Oil and Gas Conservation Commission
CR	County Road
CRAA	Chimney Rock Archaeological Area
CRMP	Coordinated Resource Management Plan
CRS	Colorado Revised Statutes
CuRMP	Cultural Resources Management Plan
CVU	Common Vegetation Unit
CWA	Clean Water Act
d.b.h.	Diameter at Breast Height
dBA	Decibels on the A-weighted Scale
DEIS	Draft Environmental Impact Statement
DG&R	Denver & Rio Grande Railway
E&P	Exploration and Production
E.O.	Executive Order
EA	Environmental Assessment
EC	Electrical Conductivity
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EPP	Emergency Preparedness Plan
ESA	Endangered Species Act
FDR	Forest Development Road
FEIS	Final Environmental Impact Statement
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
FLPMA	Federal Land Policy and Management Act
FS	U.S. Department of Agriculture, Forest Service
FSH	Forest Service Handbook
FSM	Forest Service Manual
FSR	Forest Service Road
g/HP-hour	grams per horsepower-hour
GAP	Geographic Area Plan
GIS	Geographic Information System
GMWL	Global Meteoric Water Line
gpm	gallons per minute
GPS	Global Positioning System
GRI	Gas Research Institute
H_2S	Hydrogen Sulfide
HAP	Hazardous Air Pollutant
HP	Horsepower
HSS	Habitat Structural Stages
HUC	Hydrologic Unit Code
ISCST	Industrial Source Complex — Short Term Atmospheric Dispersion Model

kg/ha-yr	Kilograms per hectare-year
kV	kilovolt
LOP	Life of Project
LOS	Level of Service
LPEA	La Plata Electric Association
LRMP	Land and Resource Management Plan
LTE	LT Environmental
MA	Management Area
MACT	Maximum Achievable Control Technology
mcf	thousand cubic feet
MEI	Maximum Exposed Individual
mg/L	milligrams per liter
mgd	million gallons per day
mi/mi^2	miles per square mile
MIS	Management Indicator Species
MLA	Mineral Leasing Act
MLE	Most Likely Exposure
MM4	Pennsylvania State University/National Center for Atmospheric Research Mesoscale Model Version 4
mmcf	million cubic feet
mmcfd	million cubic feet per day
mmhos/cm	millimhos per centimeter
msl	mean sea level
MSO	Mexican Spotted Owl
MW	Megawatt
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFS	National Forest System
NFSR	National Forest System Road
NO_2	Nitrogen Dioxide
NOI	Notice of Intent
NOS	Notice of Staking
NO_x	Oxides of Nitrogen
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSA	Noise Sensitive Area
NSJB	Northern San Juan Basin
NSO	No Surface Occupancy
NTL	Notice to Lessees
NUL	North of Ute Line
NWI	National Wetlands Inventory
OAHP	Office of Archaeology and Historic Preservation
OHV	Off-highway Vehicle
OSHA	Occupational Safety and Health Administration
P&A	Plugged and abandoned
P.L.	Public Law
PAH	Polycyclic Aromatic Hydrocarbon
PAR	Parturition Areas (Habitat)

PFC	Proper functioning condition
PM_{10}	Inhalable Particulate Matter Less than 10 Microns in Effective Diameter
$PM_{2.5}$	Fine Particulate Matter Less than 2.5 Microns in Effective Diameter
POD	Plan of Development
ppm	Parts per Million
PRB	Powder River Basin
PSD	Prevention of Significant Deterioration
Questa	Questa Engineering
RACR	Roadless Area Conservation Rule
RARE	Roadless Area Review and Evaluation
RCRA	Resource Conservation and Recovery Act
RFFA	Reasonable Foreseeable Future Actions
RMP	Resource Management Plan
RNA	Research Natural Area
ROD	Record of Decision
ROW	Right of Way
RUSLE	Revised Universal Soil Loss Equation
RV	Recreational Vehicle
S&G	Standards and Guidelines
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEO	State Engineer's Office
SH	State Highway
SHPO	State Historic Preservation Office
SHT	Self-heating Temperature
SJB	San Juan Basin
SJFO	San Juan Field Office
SJNF	San Juan National Forest
SO_2	Sulfur Dioxide
SPCC	Spill Prevention Control and Countermeasures
SUIT	Southern Ute Indian Tribe
SUL	South of Ute Line
SUP	Special Use Permit
SUPO	Surface Use Plan of Operations
SWWF	Southwestern Willow Flycatcher
tcf	trillion cubic feet
TCP	Traditional Cultural Properties
TDS	Total Dissolved Solids
TPR	Transportation Planning Region
TSI	Transportation System Inventory
TSS	Total Suspended Solids
TU	Tritium Units
UIC	Underground Injection Control
UNM	University of New Mexico
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USFWS	U.S. Department of Interior, Fish and Wildlife Service

USGS	U.S. Department of the Interior, Geological Survey
VMS	Visual Management System
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound
VQO	Visual Quality Objective
VRM	Visual Resource Management
WIZ	Watershed Influence Zones
WPA	Works Progress Administration
WRCC	Western Regional Climate Center
ybp	years before present

Executive Summary

Chapter 1 — Purpose and Need for the Proposed Action

Introduction

Pure Resources, XTO Energy, Petrox Resources, Elmridge Resources, Exok, and BP America ("the companies") propose to drill approximately 284 wells to produce natural gas from coal beds on Federal, State, and privately owned lands in La Plata and Archuleta Counties, Colorado. The companies would also construct ancillary facilities needed to support the wells. The companies' proposal includes directional well drilling to avoid steep slopes in portions of the HD Mountains, where feasible.

Purpose and Need

Private industry exploration and development of federal oil and gas leases is an integral part of the Forest Service and Bureau of Land Management's (BLM's) oil and gas leasing program under the authority of the Mineral Leasing Act of 1920, as amended, the Mining and Mineral Policy Act of 1970, the Federal Land Policy and Management Act of 1976, the National Materials and Minerals Policy, Research, and Development Act of 1980, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987.

Exploration and production of natural gas, including methane gas from coal-bearing formations, is in accordance with the President's National Energy Policy, Executive Order 13212. The policy calls for federal agencies "to develop a national energy policy designed to help the private sector, and, as necessary and appropriate, State and local governments, promote dependable, affordable, and environmentally sound production and distribution of energy for the future." Natural gas is an integral part of the U.S. energy future due to its availability, the presence of an existing market delivery infrastructure, and the environmental advantages of clean burning gas.

The purpose of and need for this project is to allow the companies to drill to develop their federal oil and gas leases and to help meet the public's need for natural gas by increasing the number of wells that produce coal bed methane (CBM). The proposed CBM development would exercise the leaseholders' existing rights to drill for, extract, remove, and market gas products. National mineral leasing policies and the regulations by which they are enforced recognize the statutory right of leaseholders to develop federal mineral resources to meet continuing needs and economic demands so long as undue and unnecessary environmental degradation is not incurred. Also included is the right of the leaseholder within

the Project Area to build and maintain necessary improvements, subject to renewal or extension of the leases in accordance with the proper authority.

This project would serve to meet the goals for management of energy minerals set forth in the Land and Resource Management Plan (LRMP) for the San Juan National Forest (FS 1983) and in the Resource Management Plan (RMP) for the San Juan/San Miguel Planning Area (BLM 1985).

Project Area

This environmental analysis of the companies' gas field development proposal focuses on a 125,000-acre Project Area in the Northern San Juan Basin (NSJB) of Colorado. The Project Area is that portion of the San Juan Basin north of the boundary of the Southern Ute Reservation, bounded on the south by the reservation and to the west, north, and east by the arcing line of the outcrop at the top of the Fruitland Formation.

The Project Area consists of 7,000 acres of Bureau of Land Management (BLM) administered land; 49,000 acres of U.S. Forest Service (FS) administered land, 9,000 acres of private lands with federal minerals, and 60,000 acres of state or privately held (fee) lands with non-federal minerals. The Project Area occupies portions of La Plata and Archuleta Counties.

Scope of Agency Decisions

This environmental impact statement (EIS) and its supporting project record are the basis for the Record of Decision (ROD) that will document the following BLM and FS decisions:

(1) Overall plan and conditions of development, including environmental protection measures that apply to the entire Project Area, or to portions of the area.

(2) Conditions under which ancillary facilities requested by the proponent may be constructed (including water and gas flowlines and compressor stations on FS or BLM lands).

(3) Conditions of approval specific to the approximately 54 pending surface use plans of operation (SUPOs) and applications for permit to drill (APDs) and related facility applications submitted by the companies, as shown on Figure 1–2.

(4) Whether to waive, allow an exception for, or modify the no surface occupancy stipulations issued May 14, 2001, on five leases within the Project Area, COC64932, COC64933, COC64934, COC64935, COC64936.

(5) Whether to continue or to terminate in whole or in part the Interim Criteria for development within the Project Area as described in Notice to Lessees (NTL) No. CO-SJFC-2000-01.

(6) Whether to amend the San Juan National Forest Land and Resource Management Plan to achieve Plan conformance for old growth and transportation system management in winter range, depending on the alternative selected.

These decisions will incorporate the terms and mitigation requirements that the agencies deem necessary to protect the surface and sub-surface resources based on disclosure of environmental effects in this EIS for CBM field development.

Project decisions will be documented in a ROD signed by the BLM and FS responsible officials and will apply to federal mineral estate only. The private mineral estate is under the administrative jurisdiction of the Colorado Oil and Gas Conservation Commission (COGCC) and is not subject to the decisions documented in the ROD for this proposal. Decisions by other jurisdictions to issue (or not to issue) approvals on to this proposal may be aided by the disclosure of impacts that is available in this analysis.

Chapter 2 — Alternatives

The alternatives were designed to respond to management concerns and issues identified through scoping. Five alternatives are analyzed in detail in the FEIS. Thematically, they represent the Proposed Action (Alternative 1), Maximum Development (Alternative 2), BLM and FS modifications of the Proposed Action (Alternatives 6 and 7), and the No Action Alternative (Alternative 5). Each of the alternatives considers the federal action, which is development of federal oil and gas leases within the Project Area, and also development on other jurisdictions, including private and state leases within the Project Area. The No-Action alternative is required under 40 CFR 1502.14.

Alternative 1 — Proposed Action

Alternative 1 is the CBM development proposal. The federal action that is the subject of federal decision-making under Alternative 1 would be to permit drilling of and subsequent production from 185 wells located on 162 well pads on federal oil and gas leases in the Project Area. Concurrent with Fruitland Formation drilling, there would be a limited number of test wells drilled to the Mesa Verde and Dakota sandstones utilizing Fruitland well pads. The federal gas field would be developed to a density of four wells per section.

The companies propose to directionally drill 25 wells on National Forest in the high elevation portion of the HD Mountains. Well pads for directional drilling are larger than well pads for single vertical wells. The 15 multi-well pads that would be needed for directional wells under Alternative 1 are located in the eastern half of T34N, R6W.

The companies also propose to construct an estimated 97 miles of collocated access roads and gathering lines, one disposal well, 7 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines.

The no-surface occupancy stipulations attached to lease numbers COC64932, COC64933, COC64934, COC64935, and COC64936 would be waived and surface occupancy of the leases assumed.

The overall life of the project, including construction, production, and reclamation, is approximately 40 years. Well construction would begin during 2006 and would continue for 5 years. The productive life of each well is expected to be about 25 to 30 years. Accordingly, production from the wells drilled at the end of the 5-year drilling period would conclude by 2040. Final reclamation of each well would take place during the 2 to 3 years immediately after the end of its productive life. Thus, the project would be completed by the end of 2042.

Alternative 2

Alternative 2 is based on the assumption that the demand and price for natural gas will significantly increase in the future, triggering development of CBM beyond that proposed under Alternative 1. As such, Alternative 2 assumes well densities of four per section throughout most of the entire Project Area. Alternative 2 differs from Alternative 1 in the number of wells that would be drilled in the Project Area. Figure 2–3 shows the distribution of drilling windows and wells projected under this alternative. The federal action that is the subject of federal decision-making under Alternative 2 would be to allow the drilling of and subsequent production from 324 wells on 301 well pads on federal oil and gas leases in the Project Area.

The no-surface occupancy stipulations attached to lease numbers COC64932, COC64933, COC64934, COC64935, and COC64936 would be waived and surface occupancy of the leases assumed

Alternative 2 would require an estimated 162 miles of collocated access roads and gathering lines, one disposal well, 10 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 2 are presented in Table 2-3.

Alternative 5 — No Action

NEPA procedural regulations (40 CFR 1502.14) require that federal agencies evaluate in detail a "No Action" alternative that provides a baseline for comparing and measuring the effects of a proposed action and other "action" alternatives. Under the "No Action" alternative, the BLM and FS would not approve the proposed CBM operations on federal leases in the Project Area.

Drilling would continue on private and state leases, and BLM and FS would grant access across federal lands where other reasonable routes are not available to reach proposed well sites on state and fee lands. A total of 15 wells in the eastern project area would be developed on split estate lands (national forest surface/private minerals), requiring construction of 17 miles of associated access road and pipeline on National Forest surface.

The Department of Interior's and Department of Agriculture's authority to implement a "No Action" alternative that precludes oil and gas development on federal leases is, however, limited. An oil and gas lease grants the lessee the "right

and the privilege to drill for, mine, extract, remove, and dispose of all of the oil and gas deposits" in the leased lands, "subject to the terms and conditions incorporated in the lease" (43 CFR 3103.1–2).

Alternative 6

Alternative 6 is developed in response to comments regarding the surface impacts of CBM development within the HD Mountains Roadless Area and the impacts that may result from drilling CBM wells within proximity of the Fruitland outcrop. Alternative 6 differs from the Proposed Action (Alternative 1) in the following ways:

- Natural gas resources in the HD Mountains Inventoried Roadless Area are developed from surface locations outside the roadless area.
- Federal mineral estate within the 1.5-mile buffer zone for the Fruitland Formation outcrop is not developed.

Approximately ten well locations could be developed as horizontal wells that drain portions of the HD Mountains Roadless Area if the technology proves to be technically and financially feasible. Approximately ½ the leased gas resource in the Roadless Area would be accessible from horizontal/directional drilling locations (Table 2-6).

The federal action that is the subject of federal decision-making under Alternative 6 would be to allow the drilling of and subsequent production from 80 wells on 78 well pads on federal oil and gas leases in the Project Area.

Alternative 6 would require an estimated 47 miles of collocated access roads and gathering lines, one disposal well, 5 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 6 are presented in Table 2-6.

Lease numbers COC–64935 and COC–64936 are maintained as no-surface-occupancy leases. The no-surface occupancy stipulations attached to lease numbers COC–64932, COC–64933, and COC–64934 would be waived and surface occupancy assumed.

Alternative 7

Alternative 7 is developed in response to comments and is the BLM/FS preferred alternative. Alternative 7 differs from the Proposed Action (Alternative 1) in the following ways:

- Three areas of National Forest where access roads overlay areas with high potential for landslides and mass wasting, are not included in the Project Area in Alternative 7: the lower and upper Ignacio Creek (Zone 1), the area south of the Piedra Stock Driveway rock bridge (Zone 2), and the proposed wells accessed to the south by FS Road 743 (Zone 3)

(Figure 2–6). The three zones are not part of this alternative, and decisions for federal actions will be considered when the companies submit site-specific proposals, supported by engineered designs, for those three areas. From the standpoint of describing the environmental impacts of Alternative 7 the three areas are treated as undeveloped.

- Portions of lease numbers COC–64935 and COC–64936, approximately 1,500 acres, are maintained as no-surface-occupancy leases. The no-surface occupancy stipulations attached to lease numbers COC–64932, COC–64933 and COC–64934 are waived and surface occupancy is assumed.

- CBM development within the 1½-mile buffer zone for the Fruitland Formation outcrop in the Fosset Gulch Federal Unit proceeds in a stepwise fashion. Approximately 14 wells, mostly on private minerals estate underlying federal surface in T.33N, R.5 W., Sections 9U, 10U, 15U, 16U, 22U, and 23U, would be drilled first. This clustered development would be monitored according to current state requirements for well performance, well interference, water production, and effects to domestic water wells, springs seeps, and the Fruitland outcrop (Section 3.3.10). If monitoring data from these wells indicate identifiable and measurable undesirable effects from production on other production wells, nearby water wells, springs, seeps, and the outcrop, then subsequent wells may be conditioned to prevent or minimize additional or exacerbated effects. This stepwise approach to the development of the near outcrop zone (¾ miles to 1½ miles) in the eastern Project Area would allow the orderly collection of important production data that would aid in future APD approvals.

The federal action that is the subject of federal decision-making under Alternative 7 would be to allow drilling of and subsequent production from 138 wells on 127 well pads on federal oil and gas leases in the Project Area.

Alternative 7 requires an estimated 72 miles of collocated access roads and gathering lines, one disposal well, 5 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 7 are presented in Table 2-7.

Chapter 3 — Affected Environment and Environmental Consequences

The affected environment is briefly described and includes the physical, biological, social, and economic resources that the alternatives may impact.

The environmental consequences summarized in this section focus on the most important impacts of Alternative 7 — the BLM and Forest Service preferred CBM development alternative. "Preferred" means Alternative 7 represents the

alternative the BLM and Forest Service would likely select in their respective records of decision (RODs). Table S–1 describes and contrasts the environmental consequences of each of the alternatives evaluated in detail in summary form. The effects described are direct and indirect effects that may occur as a result of development of federal mineral estate. Where the intermingled jurisdictions prevent distinctions between impacts caused by federal wells vis-à-vis private and state wells, the impacts are described in the aggregate. Chapter 3 of this FEIS describes both the impacts of the federal action and the comprehensive impacts of CBM development across all jurisdictions in the Project Area. A larger cumulative effects area that addresses CBM development within the Colorado portion of the San Juan Basin is also analyzed.

Table S–1 Comparative Summary of Alternatives Considered in Detail — CBM Development Activity on Federal Mineral Estate

		Alternative				
Parameter	Existing	1	2	5	6	7
CBM Wells (number)	276	185	324	0	80	138
CBM Well Pads (number)	276	162	301	0	78	127
Short-Term Disturbance (acres)	NA	788	1,293	113[2]	415	650
Long-term Disturbance (acres)	NA	487	833	53	270	381
Roads/Pipelines (total length in miles)	191	97	162	17	47	72
Produced Water Disposal Wells (number)	6	1	1	0	1	1
Compressor Stations (number)[1]	6	7	10	1	5	5
Trunk Pipelines (Total length in miles)	6	6	6	6	6	6

Note:
1. Number of compressor stations resulting in new surface disturbance.
2. Land disturbance as a result of split estate development (National Forest surface/private minerals).

Methane Seeps

Concerns related to methane seepage at the Fruitland Formation outcrop include: the potential for seeps to impact groundwater aquifers and surface water resources; human health and safety concerns; potential for seeps to impact vegetation and soils; potential for hydrogen sulfide seeps; and potential for propagation of greenhouse gasses. Methane seep impacts in the western Project Area are the result of development on all mineral jurisdictions, while impacts that may occur in the eastern Project Area are primarily the result of Federal and private CBM development. Key findings:

- Groundwater resources along the Fruitland outcrop are affected by CBM development and would continue to be affected beyond the life of the project. With CBM development expanding eastward into Archuleta County, groundwater resources on the Fruitland Formation outcrop in Archuleta County may be affected by increased methane seepage. Further CBM development would increase the areas of the Fruitland outcrop that are affected by active methane seepage. Thus, the number of shallow domestic wells, seeps, and springs affected by methane seepage would increase. Any number of the 40 water wells on the Fruitland Formation outcrop may be affected by increased methane concentrations. The companies would continue to monitor

domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop for change in water quantity and quality.

- Surface water affected by CBM development is limited to small springs emanating from the Fruitland Formation and the Pictured Cliffs Sandstone. Larger bodies of surface water (Texas Creek; the Animas, Pine, and Florida Rivers) are already subject to methane seepage from naturally occurring methane seeps and from the current CBM well field. These seeps are not predicted to increase in overall rate. Therefore, methane seepage from additional CBM development would not further impact these surface water bodies. Squaw Creek, at Yellowjacket Pass, may experience increased methane seepage, and other unnamed springs along the eastern portion of the outcrop may additionally be affected by methane seepage, as may the Piedra River. Baseline monitoring has been conducted to identify springs and seeps along the Fruitland Formation outcrop. The springs and seeps would continue to be monitored for qualitative and quantitative changes. Remediation of potential impacts could include limiting water production from CBM wells or other measures as necessary to address impacts to affected parties.
- There are no observable effects on water quality or aquatic life at the existing pre-CBM methane seeps in the Animas, Pine, and Florida Rivers. Increased methane seepage to surface water bodies is not expected to affect other resources and would negligibly affect surface water chemistry.
- Current methane seepage has affected an estimated 130 acres of vegetation. The total affected area is likely to increase somewhat, even under a No Action development scenario. The Preferred Alternative could result in vegetation die-off on upwards of 510 acres, in addition to the 130 acres affected by the existing CBM well field (640 acres total potentially affected). Mitigation measures include revegetation of affected areas if site condition permit regrowth
- There are 60 residential-type structures on the outcrop of the Fruitland Formation in the Project Area. These structures may be affected by methane seepage and buildup associated with CBM development in the area. Homes of potentially affected landowners would be continuously monitored for methane seepage.
- The amount of methane lost to seepage at the outcrop areas would increase along with the areal extent of active seeps. Seepage would increase between the Animas River and Beaver Creek. Approximately 15 miles of outcrop area between Beaver Creek and the Piedra River may also be subject to increased seepage.

Minerals and Geology

The Project Area lies entirely in Colorado, within the Colorado Plateau physiographic province. This province extends throughout western Colorado, northwestern New Mexico, northeastern Arizona, and southern and eastern Utah. Characteristics of this physiographic province include an expansive, dissected, high-elevation land surface with relatively low relief when compared with surrounding mountainous regions. Additional CBM development raises the following concerns: potential for geologic and paleontological impacts; conflicts with other mineral development; potential for landslides due to construction in unsta-

ble areas; potential for underground injection of produced water to trigger earthquakes; and potential for coal fires. Key findings include:

- CBM development would alter naturally occurring outcrops and deposits whenever surface exposures are excavated. The stratigraphy, structure, and contacts between geologic units would not be affected, however.
- Little of the Project Area has been inventoried for the presence of paleontological resources. As a result, the number of paleontological sites that may be affected cannot be accurately estimated. Paleontological resources contained in near-surface horizons of soil and surficial deposits have likely already been impacted by natural processes or human activity. Surface use and shallow excavations likely would have little or no effect on paleontological resources that occur just below the surface. All facilities constructed on federal mineral ownership would be considered federal undertakings, and thus would be subject to federal guidelines and regulations that protect paleontological resources.
- Because there are no active coal mines in the Project Area, CBM development is not expected to impact coal mining. Locating wells in areas where future mining may take place would preclude mining during the life of CBM wells located in the area proposed for mining. Coal in these areas could be mined after CBM extraction ceases or is terminated, or through a negotiated agreement between the CBM lessee(s) and operator(s), and the coal lessee(s) and coal mine operators.
- Surface disturbance could exacerbate existing landslides and cause new landslide hazards in the Project Area. Based on the preliminary location of proposed access roads, eight miles of new roads would cross high landslide hazard areas on national forest and BLM public lands. Twelve proposed well pads would require cut and fill construction in areas of high landslide hazard. Landslides could be activated during facility construction. However, the use of facility design and construction best management practices and mitigation measures that minimize the risk of landslides would reduce landslide potential within the Project Area.
- No excessive buildup of pressure within rocks or fracturing of rocks is anticipated to result from produced water injection. Therefore, no underground injection triggered earthquakes would be expected. Underground injection would be conducted in accordance with federal and state regulatory requirements. Injection wells would be authorized only where the injection zone is sufficiently porous and permeable that fluids could enter the rock formation without causing an excessive buildup of pressure or fracturing of rocks.
- Removal of water from the Fruitland coal seam would not cause noticeable ground subsidence or aquifer compression in the Project Area under any of the alternatives. Water would be extracted from the Fruitland formation, which is a consolidated rock unit and, therefore, would not be susceptible to noticeable subsidence.
- Partial removal of water from the coal seam near the coal outcrop during CBM development depressurizes the coal seam and could create a condition where oxygen replaces water in the coal seam and increases the risk of spontaneous combustion. The risk of underground coal fires would be limited to the area where oxygen is available to sustain coal fires. Oxygen would be introduced to the shallow subsurface environment through conduits to the sur-

face, such as well bores or naturally occurring fractures. However, unless enough oxygen is able to reach the dewatered coals to sustain combustion, underground coal fires would not occur. The conditions affecting the availability of oxygen near the outcrop would not be expected to vary among the alternatives, provided proper well drilling and operation procedures are followed.

Ground Water

The Fruitland Formation and Pictured Cliffs Sandstone are unconfined at the outcrop where they are recharged. The aquifer is confined several hundred meters down dip and throughout the San Juan Basin, where the overlying Kirtland Shale acts as an aquitard. Flow of groundwater in the Fruitland Formation occurs primarily in the higher-permeability coal beds. Although coal beds are not laterally continuous across the entire Project Area, they are sufficiently interconnected to allow the Fruitland Formation to act as a single aquifer system. Flow within the Pictured Cliffs Sandstone appears to occur in fracture zones and in some areas of higher primary permeability. Groundwater concerns include: the potential for CBM dewatering to deplete groundwater in shallow aquifers; the effect of groundwater withdrawal on outcrop seeps and springs; effect of produced water injection on basin hydrology; and the effect of dewatering and injection on groundwater. Groundwater impacts in the western Project Area are the result of development on all mineral jurisdictions, while impacts that may occur in the eastern Project Area are primarily the result of Federal and private CBM development. Key findings include:

- Dewatering the coal beds will not affect the shallow aquifers within the interior of the Basin that supply almost all the domestic wells, municipal wells, and livestock wells within the Project Area. Increased CBM development will, however, continue to draw down the water levels in wells located along the outcrops of the Fruitland and Pictured Cliffs formations. As many as 40 well owners may be affected by lower water tables in the outcrop area. The two deeper wells known to draw water from the Pictured Cliffs Sandstone are not likely to be affected to any significant degree by increased CBM development. Rather lowering of the water levels in these two wells will continue as a result of the existing level of CBM development.
- Draw down of the water table along the Fruitland outcrop may affect groundwater seeps and springs. Impacts in the western Project Area are not expected to increase as a result of the Proposed Action. In the eastern portion of the Project Area, the water table along the outcrop may be drawn down, possibly affecting springs and seeps. Baseline monitoring has been conducted to identify springs and seeps along the Fruitland Formation outcrop. The springs and seeps would continue to be monitored for qualitative and quantitative changes. Remediation of potential impacts could include limiting water production from CBM wells or other measures as necessary to address impacts to affected parties.
- Although the deep hydrology of the Basin would be affected by injection of produced water, these impacts are not expected to manifest themselves in shallow aquifers or usable groundwater supplies. Impacts would not be evi-

dent because injection wells are constructed and operated according to current regulations and best engineering practices.

Surface Water

There are four main stem rivers within the Project Area. They are, from east to west, the Piedra River, Los Pinos River (Pine River), Florida River, and Animas River. The Piedra River is an unregulated stream that flows from the northeast directly south to Navajo Reservoir. The main tributary east of the Piedra River within the Project Area is Stollsteimer Creek, which has its confluence with the Piedra River just south of the Project Area. West of the Piedra River are several ephemeral steams, including Squaw Creek, Fosset Gulch, and Bull Creek. In addition, Turkey Creek, Goose Creek, and Ignacio Creek also drain portions of the Project Area on an intermittent basis, but have their confluence with the Piedra River just south of the Project Area within the Southern Ute Indian Reservation. CBM development concerns include: the potential for surface water degradation as a result of petroleum product and produced water spills; the potential for reduced surface water flow to affect riparian areas and wetlands; the consumption of domestic and irrigation water for well development; and the effect of water depletions on existing surface water rights. Key findings include:

- Potential short-term surface water quality impacts could occur as a result of accidental spills of fuel, lubricants, and fluids during facility construction in water influence zones (WIZ). Long-term impacts over the life of the project could occur from leaks or breaks in the pipelines that run from the wells to the disposal facilities. To mitigate these impacts, facilities would be located outside of the WIZ, where possible, and operations would adhere to spill prevention control and countermeasures (SPCC) plans that incorporate best management practices (BMPs).
- Development of CBM wells on federal mineral estate would impact 50 acres of water influence zone (WIZ) in the short term and 33 acres in the WIZ in the long-term after partial facility reclamation. This disturbance would lead to potential annual sedimentation within the WIZ of 450 tons per year in the short term and 320 tons per year in the long term. Well pads and roads would be relocated or realigned to avoid WIZ disturbance where possible. Complete avoidance would not be possible.
- Depletions are predicted to be less than one percent of base flow in the Animas, Pine, and Florida Rivers. Localized impacts to wetland and riparian areas could occur along perennial and ephemeral drainages crossed by access roads.
- Springs and seeps may be physically impacted by CBM wells and ancillary facilities. Proposed wells would be relocated to physically avoid these moist areas where possible.
- Over the life of the project, 81 acre-feet of water would be required for drilling of federal wells. Water would be purchased from municipal sources, private entities, or produced water would be used. Individual landowners would negotiate terms for the purchase of water. In total, about 0.03 percent of irrigation use would shift to industrial use.
- The process of dewatering the Fruitland coal bed to free gas would physically reduce the amount of Fruitland formation recharge of local rivers. Ex-

isting water users would be affected by annual 140 acre-feet depletions in the Florida, Pine, and Animas Rivers and 15 to 60 acre-feet depletion in the Piedra River. Existing surface water rights may be impacted.

Soils

Soils within the Project Area have developed in residuum, colluvium, alluvium, and, to a lesser extent, in eolian materials derived from inter-bedded sandstones and shales in the lower areas. They also have developed from igneous and metamorphic materials in the higher, more mountainous areas. Surface textures range from clay loams to sandy loams with varying amounts of gravel or coarser materials. Slopes range from nearly level to very steep, with deeper soils found in the less steeply sloping areas. Additional CBM development presents concerns about constructing facilities in areas with sensitive soils and high potential for erosion, and within water influence zones. Key findings include:

- CBM development of federal mineral estate would impact 40 acres of soils with high potential for water erosion and 15 acres of soils with high potential for wind erosion during construction. During operation and maintenance, 30 acres of soils with high potential for water erosion and 10 acres of soils with high potential for wind erosion would remain impacted after partial reclamation of facilities. Watershed BMPs would be utilized and roads would be constructed according to BLM Gold Book standards to minimize erosion.
- Overall, 50 acres of surface disturbance would occur within water influence zones during construction on federal mineral estate; 33 acres would remain impacted within WIZs during operation and maintenance. Projected additional soil erosion above baseline from all impacted portions of federal mineral estate would be 5,700 tons per year during construction and 3,800 tons per year during operation and maintenance. Approximately 450 tons of soil would be expected to erode annually as a result of construction in WIZ, and 320 tons of soils are projected to erode annually during operation and maintenance within WIZ. Watershed best management practices would be utilized to minimize erosion.

Vegetation

There are nine general vegetation types found in the Project Area: grasslands, sagebrush, pinyon-juniper, mountain shrub, Gambel oak, ponderosa pine, mixed conifer, aspen, and riparian. Across the landscape, many of these vegetation types occur in a mosaic, depending on slope, aspect, soil type, and other physical parameters. Three additional land cover types, agriculture, barren, and water, are also found in the Project Area. CBM development raises concerns about effects of facility construction on vegetation, including wetlands, riparian areas, and old growth ponderosa pine forests. Key findings include:

- Approximately 530 acres of vegetation would be removed as a result of well pad, compressor station, pipeline, and road construction on federal mineral estate. Ponderosa pine, pinyon-juniper, and Gambel oak would be the cover types most affected. Facilities would be partially revegetated following construction. Full reclamation would occur after the production phase. Following site construction unused portions of facilities would be revegetated, reducing

the area of initial site disturbance. Following facility abandonment, all facilities would be reclaimed.

- Loss of wetlands and riparian areas may occur despite the intention to avoid these environmentally sensitive areas whenever possible. Well pads and compressor stations would be located in upland sites where they would not impact wetlands and riparian areas. Linear facilities would not be constructed across perennial streams and rivers where wetlands and riparian areas are most common and generally best developed. Linear facilities would, however be constructed across approximately 115 intermittent streams where some wetlands and riparian vegetation may exist and be impacted. Best management practices would be utilized to reduce effects of CBM-related sedimentation to wetlands and riparian areas.
- Weed seeds may be introduced accidentally as a result of project activity. The probability that noxious weeds would be introduced cannot be quantitatively predicted. However, noxious weed infestations have been found in association with ground disturbance from existing CBM development on federal and private lands in the Project Area. Control of existing noxious weed infestations on federal lands has generally been successful, while results have been mixed on private lands. Mitigation measures designed to prevent the introduction and spread of noxious weeds would be implemented. However, complete prevention and control of weeds is unlikely.
- Portions of old-growth ponderosa pine stands may be removed by construction. Without avoidance mitigation, the Preferred Alternative would impact 13 acres of old growth pine, approximately 2 percent of the old growth present on the National Forest portion of the Project Area. To the extent practical, old growth stands would be avoided during road and well pad staking. However, until firm locations are proposed during APD submittal, the effective ability to move facilities to avoid old-growth impact is unknown.
- During the development phase of the project, cut trees and limbs would be present along roads and at well pads and may increase infestations of the *Ips* beetle. By attracting more beetles, the surrounding trees that are not directly affected by construction would be at greater risk of insect attack. Mitigation measures designed to ensure timely removal of wood from construction areas would be implemented to reduce the potential for increased insect populations from CBM development.
- One federally listed plant species, six FS sensitive plant species, and three BLM sensitive plant species may occur in the Project Area and may be affected by the proposed project. Pre-construction surveys for these species would be conducted in all suitable habitat and impacts minimized by avoidance mitigation.

Wildlife and Fisheries

The Project Area is located at the interface of the Colorado Plateau physiographic province and the Southern Rocky Mountains physiographic province. The location of the Project Area at this interface makes it valuable to many species of wildlife. Wildlife species and habitat elements common to both of these physiographic provinces are found in the Project Area. Species that utilize the higher, moister, conifer-dominated habitats of the Rocky Mountains are found in the

eastern third of the Project Area. Species more typical of the warmer, drier Colorado Plateau occur in the western two-thirds of the Project Area. Migratory species, such as big game and many bird species, move back and forth across the Project Area with the seasons. Of concern is whether increased CBM development would result in increased wildlife harassment, road-kill, hunting pressure, and wildlife displacement; the potential for loss of suitable wildlife habitat; habitat fragmentation; disruption of migration routes; and loss of long-term viability of wildlife populations. Of further concern is how additional CBM development would affect Federal and State listed threatened, endangered, proposed, candidate, and sensitive animal species and their habitats. Key findings include:

- Direct loss of approximately 530 acres wildlife habitat would occur on federal mineral estate during the construction phase of the project as a result of road, well pad, and other facility construction. Habitat loss would reduce available forage and habitat components in the affected area. Habitats next to those directly disturbed may be degraded by changes in vegetation, including the invasion of noxious weeds. The amount of habitat directly impacted by the Preferred Alternative would be one-percent or less of available habitat for each MIS.
- Most of the habitat impact would be on national forest in the HD Mountains because it is currently the least developed and would experience the most new development. The west side of the Project Area is extensively developed agricultural and residential land and has experienced the most CBM development to date. Future CBM development on the west side of the Project Area would add a small increment of direct habitat loss to the landscape. To partially offset direct habitat loss, unused portions of well sites would be restored during the production phase. At the end of the production phase, all facilities would be removed and disturbed areas restored to pre-construction vegetation types where feasible.
- Approximately 67 miles of new road would be constructed on federal mineral estate under the Preferred Alternative. These roads would provide increased access to public land in the Project Area as a whole, potentially leading to increased legal-hunting pressure and poaching. Most newly constructed roads would be gated and locked to reduce motorized access and human-wildlife impact.
- Wildlife displacement during the construction phase may alter patterns of habitat use and movements for individual animals, but would result in minimal disruption of seasonal habitat use or movement for entire herds because of the large areas occupied by these herds and the scattered nature of anticipated development. Wildlife displacement during the production phase would result in only minimal alteration of habitat use and movement patterns for both individual animals and entire herds, because of habituation to regular low-grade disturbance.
- Most project roads would be designed for slower speeds and not likely to cause a substantial increase in vehicle collisions. Most collisions occur on county roads and highways, where speeds are greater and where the vast majority of traffic is not CBM-related. Nevertheless, an increase in CBM traffic would occur on these roads, as well, and a minimal increase in vehicle collisions may occur.

- Construction and operation of project-related facilities would result in the fragmentation of wildlife habitats in the Project Area and on NFS land. Fragmentation would occur through loss of narrow strips along roads and small patches at well pad and facility sites.
- Management indicator species (MIS) populations are considered viable and well distributed across the region, the National Forest, and Project Area. Reduced population is generally a concern if a substantial proportion of available habitats is lost or reduced in effectiveness for a long period. The project would not contribute measurably to an alteration of the stable population trends for MIS species that prevail at the National Forest unit level. Nor are substantial losses of habitat projected for any of the alternatives on NFS land, or in the Project Area. On private lands, there may be reduced population levels in the Project Area's west side, where residential development has accelerated over the past decade.
- The current Rocky Mountain Region endangered, threatened, proposed, and sensitive species list contains special status species of concern within the region. Based on a screening of the list, it was determined that Canada lynx, bonytail chub, humpback chub, and Uncompahgre fritillary butterfly are not expected to occur in the Project Area. Species thought to occur or that have suitable habitat within the project area include: Bald eagle, Mexican spotted owl, Southwestern willow flycatcher, Colorado pikeminnow, razorback sucker, and Knowlton's cactus.
- The Preferred Alternative may affect but is not likely to adversely affect the bald eagle, Mexican spotted owl, southwestern willow flycatcher, and Knowlton's cactus and their habitat in the Project Area.
- It has been the position of the FWS that any depletion of water from the San Juan Basin, regardless of magnitude, timing, duration, or source, contributes to the overall cumulative effect of water depletions on the endangered fishes and has the potential to jeopardize the population viability. In keeping with previous findings for like actions, the Preferred Alternative may affect, and is likely to adversely affect, the Colorado pikeminnow and razorback sucker.
- There are 20 FS and BLM sensitive species that were analyzed in detail and 21 species that were eliminated from further analysis because they are not expected to occur in the Project Area. The Preferred Alternative would not impact a number of these species, but for other species evaluated in detail, the Project may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability range wide.

Cultural Resources

Cultural resource sites include the physical locations and material remains of past and present cultures, including properties of traditional religious and cultural importance (hereinafter called traditional cultural properties), and areas of traditional use. The principal issues regarding cultural resource sites, traditional cultural properties, and areas of traditional use in the Project Area are the potential direct, indirect, and cumulative effects of further CBM development. Key findings:

- The Preferred Alternative will affect 55 known cultural resource sites or isolated finds. Twenty-two of the sites are recommended eligible or unevaluated. Forty-one of the cultural resources are on federal surface and seventeen of those are recommended eligible or unevaluated for the National Register. The unevaluated sites will be evaluated and plans will be developed to avoid or mitigate impacts to all eligible sites.
- In oil and gas development, avoidance and protection are the preferred mitigation measures for historic properties, and it will be feasible to avoid and protect the majority of historic properties. Well field development also would improve access to the vicinity of some historic properties, increase traffic and activities near cultural resource sites, and increase the potential for inadvertent effects from unrelated activities. The combination of past, present, and reasonably foreseeable oil and gas leasing, other recent and planned projects in the region, plus the increase in the number of visitors to the area, will incrementally increase the cumulative effects to historic properties.

Land Use

The pattern of surface ownership is distinctly different in the western and eastern portions of the Project Area. Surface ownership in the western half of the Project Area consists primarily of private property intermingled with federal (BLM) and state lands. The BLM San Juan Public Lands Center administers the federal lands within the San Juan/San Miguel Planning Area. The eastern half of the Project Area is mostly federal land within the SJNF, administered by the Forest Service Columbine Ranger District. Land use concerns include: the effect of additional CBM development on agricultural and residential land uses; whether CBM development would be consistent with the adopted land use plans and policies of federal, state, and local agencies; and the effects of additional development on the HD Inventoried Roadless Area and roadless lands in general. Key findings include:

- Land use conflicts are most likely to occur where CBM wells are located on split estate properties that have private surface ownership without mineral estate ownership (severed minerals). In some cases, landowners are not aware of the severed mineral rights until they receive a notice that the lessee intends to drill a well on the property. The specific locations for CBM facilities would be negotiated with landowners on split estate lands and the responsible agency requires an executed landowner agreement for drilling approval when federal mineral estate is involved. A well can be drilled without a binding landowner agreement but this action is normally preceded by legal action and a court order allowing a well to be drilled under protest with actually damages between contestants being determined after drilling. Surface owners would generally be compensated for the value of land displaced by CBM facilities. There have been, and most likely will continue to be conflicts between some surface and mineral estate owners over the adequacy of compensation.
- An increase in the number of roads constructed in grazing areas and additional project-related traffic would increase the potential for disturbance or harassment of animals or collisions with livestock. New access roads or addi-

tional fencing that bisects fields may also fragment rangeland and limit movement of livestock.

- Conflicts would continue where CBM development encroaches on subdivisions and individual residences. The land use codes designed to reduce CBM development impacts cannot fully mitigate these land use conflicts. These conflicts are particularly acute where surface landowners derive no monetary benefit from the well's production and incur possible property value loss due to CBM development.
- Intrusive effects to adjoining or nearby residential properties would occur from the sights and sounds of CBM-related activities. These effects may include increased fugitive dust, noise, and traffic delays on the roads; physical intrusion of the crew and equipment; and visual or aesthetic effects that could devalue residential properties. Some of these effects would occur during the construction phase of CBM development and would be limited in duration because a well drilling would be completed within several weeks.
- Thirty well pads and 13 miles of road would be constructed in the unroaded portion of the HD Mountains. Approximately 16 percent of the existing unroaded area would be impacted, leaving a residual area of 23,300 acres unroaded. The spine of the HD Mountains Inventoried Roadless Area would be developed from the terminus of FSR 756 in a north-south pattern that approximately follows the old stock driveway.

Recreation

The landscape in the Project Area ranges from rural on private land in La Plata County to a mostly natural-appearing national forest in the eastern half. Oil and gas operations have added an industrial component to the landscape, primarily on state, and private land in La Plata County. Additional wells would increase this industrial component of the landscape and add new sources of vehicle traffic and noise that would diminish the recreational experience and alter the rural ambience sought by recreationists. The gas well access roads would be gated and closed to public motorized use. Key findings include:

- Local residents value the federal land for recreation because of its proximity and the relative solitude that can be achieved within a short distance from their home. The solitude and natural setting now experienced on the public land would be most impaired by the project during the 5-year construction period. Recreationists would encounter wells and roads where there had been for the most part, natural appearing landscapes.
- In partially developed portions of the Project Area, the number of wells would double, further altering the natural appearance of the landscape and the backcountry ambiance of the area. Access to the SJNF would be altered by development of an extensive road system. The opportunity to recreate in an undeveloped landscape would be lost over much of the national forest portion of the Project Area. This impact would continue through the life of the project.
- Construction-related noise would reduce the quality of the recreational experience in general whenever a recreationist is near construction. Noise levels could increase in the long term in localized areas, as well, because of CBM compressors and continued use of pumps.

Transportation

The transportation network that serves the Project Area consists of federal and state highways, county roads, National Forest System Roads (NFSRs), and BLM roads. Workers and vehicles hauling equipment and supplies to the Project Area would use this network. Three types of impacts are of concern: additional traffic on county roads and existing roadway congestion; the potential for increased traffic accidents in the Project Area; and conflicts with public access to existing residential uses from CBM traffic on county roads. Key findings include:

- The largest increases from CBM-related traffic would occur on County Road (CR) 223, averaging 27 daily vehicle trips for each year through 2020. The maximum projected ADT for all vehicles is 385 in 2020. The total daily traffic of about 412 vehicles in 2020 is within the maximum design capacity of 999 for CR 223. County Road 225 and CR 501 are the other county roads that would experience increases that exceed one percent in daily traffic from additional CBM maintenance vehicles. These increases slightly exceed one percent of the ADT for the base year of 1998.
- County Road 228, CR 234, CR 501, and CR 509 include road segments where the rate of accidents is high. These roads provide access to residential subdivisions within and north and south of the Project Area. The increase in daily traffic levels projected from anticipated CBM-related maintenance traffic is small, between 2003 and 2020. Impacts beyond 2020 are expected to be similar in magnitude and intensity. There would be no perceptible effect on the overall rate of accidents on county roads because the volume of traffic from anticipated CBM development on most of these roads is projected to be less than 1 percent.
- Light trucks account for about 29 percent of the total number of trips by CBM construction vehicles. The costs for road maintenance from light trucks are the same as from deterioration caused by other passenger vehicles. The total 31,800 vehicle trips by light trucks would be spread out over an estimated 5-year construction period for all wells proposed for the Project Area. Light-truck traffic associated with each well would be temporary, occurring over an estimated construction and installation period of 2 to 3 weeks.
- Heavy truck traffic would account for about 25 percent of the total number of trips by CBM construction vehicles. Heavy truck traffic would result in increased costs for road maintenance because they cause more damage to road surfaces of all types than do automobiles and light trucks. It is anticipated that county road maintenance cost would increase from construction-related truck traffic.
- When the project is complete, all roads constructed specifically for the project would be removed, with the exception of those that the Forest Service retains for administrative purposes.

Visual Resources

The western portion of the Project Area is characterized by rolling hills, mesas, plateaus, and hogbacks, interspersed with broad to narrow drainages. The eastern portion of the Project Area consists of mountainous terrain mixed with upland hills, rolling uplands, ridges, and narrow valleys, as well as river valleys. Public

sensitivity to landscape modification is relatively high. Reflecting this sensitivity, current objectives for management of visual resources on public land control the degree of alteration that may be allowed in the landscape. Key findings:

- Long-term impacts would result from the addition of wells and access roads to the landscape and the permanent disturbance of land that would be used for associated facilities, such as gathering lines, well service roads, and access roads. The most visible component of the proposed facilities would be the pumping units at each well site. Gas-gathering and water pipelines would be buried adjacent to rights-of-way for existing and new roads.
- During the 6- to 12-day construction period, the presence of heavy equipment and dust generated by construction and traffic would detract from the visual quality of the landscape at each well location. These actions could conflict with residential and recreational uses because they would be visually and audibly intrusive. Night lighting would also be visible during this period, because drilling occurs on a 24-hour basis. Visual impacts would be greater for well locations near residential areas, along roads, and in open areas that are not screened by topography or vegetation. Construction would be spread over the 5-year construction phase.
- After construction is complete, well pads, new access roads, and pipeline and utility trenches would all appear as visible alterations of the landscape. Exposed soils and rock would replace landscapes that had previously been covered with natural appearing vegetation. These disturbed locations would present a visible contrast to the observer for a period of several months to several years. The duration of this impact would depend on the success of revegetation.
- The addition of wells and associated access roads would result in a mixed rural and industrial landscape. Development in the western portion of the Project Area would incrementally alter the already modified landscape character that has been impacted by residential, commercial, agricultural, and gas well development. The components with the highest potential to affect the visual character of the area adversely are the well pad clearings, pumping units, access roads, and pipelines. Operation of the proposed facilities would introduce new elements of form, line, color, and texture into the landscape and would essentially dominate foreground views. They would be visible in middle ground and background views in flat areas that are less vegetated.
- Nighttime lighting of compressor stations would also result in increased viewshed sensitivity. Permanent yard lighting has historically been installed for safety and security. This lighting typically consists of low-pressure sodium vapor fixtures arranged around the site so that the equipment can be safely operated during darkness.

Noise

Elevated noise levels would result from vehicles and operation of construction equipment during each phase of construction. Construction noise would be temporary, however, at each location. Well pad construction would last less than 30 days. Road construction would require about 7 days for each mile. Key findings include:

- Noise during the drilling phase would exceed pre-existing levels (74 dBA at 200 feet from the rig). Additionally, it would ensue 24 hours a day for the 8 days that are generally needed to drill a CBM well. During the operational phase, sources of noise would then be limited to periodic vehicle trips to the well sites and the pump jacks. Noise emanating from pump jacks would range from 67 dBA at 50 feet from the well to 50 dBA at 375 feet.
- A Caterpillar model 3516 is an example of the engines that would be installed at compressor stations. The exhaust produces a noise of 109 dBA at 4.9 feet. The mechanical noise from the engine produces 99 dBA at 3.2 feet. The enclosed building where the compressor engine operates would reduce noise by about 20 dBA. Therefore, the effective noise level would be 89.4 dBA at 5 feet from the edge of the building enclosure. The noise emanating from the compressor would decrease to 55 dBA (the COGCC daytime limit) at 250 feet from the edge of the compressor building, and to 50 dBA (the COGCC nighttime limit) at 450 feet from the building.
- Although noise levels near all CBM facilities would be similar, CBM development in the eastern portion of the Project Area would occur on NFS land distant from populated areas and would not affect established NSAs. CBM development noise could affect NSAs in the western portion of the Project Area, however. Proposed development involves 69 well locations or windows located within or immediately adjacent to the existing and proposed subdivisions.

Social and Economic Values

Social and economic issues include: the effects of CBM development on tourism and tourism revenues and the sales tax revenue, employment, and income tax proceeds derived from tourism; potential for creating a boom or bust economy; the impact of continued CBM development on county revenues from gas royalties and taxes; impacts on demographics, employment, and infrastructure; and the effect of gas wells on residential property values. Key findings:

- CBM and conventional gas development has not affected tourism for the past 10 years and is unlikely to affect tourism during the life of the project.
- Revenues, jobs, and personal income would likely peak by the year 2010 and gradually decline until gas production ends about 2035. Although CBM revenues and jobs would gradually decrease, the population is projected to steadily grow. The two counties could direct some of the gas revenues toward future years. Long-term growth and diversification would likely somewhat offset the gradual decline in CBM revenues.
- County revenues would be in the form of *ad valorem* property taxes. It is estimated that La Plata County would receive $33 million over the life of the project, and Archuleta County would receive $14 million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.
- Employment associated with CBM development would be 2 percent of total employment. With 750 new jobs, the population increase would be insignificant.

- Property values have increased by about 7 percent per year during the past decade. Although some property values may decrease in close proximity to wells, they would be expected to increase in value after the life of the project at the same relative rate as properties distant from wells.

Health and Safety

Health and safety concerns include: the risks to human health associated with underground coal fires; health risks of hydrogen sulfide seeps; the potential for accidental spills from generation, handling, and storage of hazardous and non-hazardous chemicals and wastes. Key findings include:

- Risk of ignition or re-ignition of coal fires would be low to moderate.
- Since the overwhelming majority of existing CBM wells do not produce hydrogen sulfide, the risk of exposure is extremely low.
- The risk of a spill would be proportional to the amount of chemicals and hazardous materials transported, stored, and used. The operator's adherence to regulations and required environmental health and safety plans would minimize the potential for spills.
- Standard safety procedures for drilling, pipeline markers, monitoring, and inspections are required to minimize the probability of a well blowout, undetected gas leak, or well fire. Adherence to these procedures and development of emergency plans with defined fire prevention and fire fighting procedures minimize the risk.

Air Quality

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (i.e.; separation and dehydration heaters, and pipeline compression engines), are potential causes of air quality impacts. These issues are more likely to generate public concern where natural gas development activities occur near residential areas. The USDI-National Park Service and the USDA-Forest Service have also expressed concerns regarding potential atmospheric deposition (acid rain) and visibility impacts within distant downwind mandatory federal Prevention of Significant Deterioration (PSD) Class I areas under their administration (Mesa Verde National Park and the Weminuche Wilderness Area). Key findings include:

- Significant air quality impacts would not occur under the Preferred Alternative. No violations of applicable state, tribal, or federal air quality regulations or standards are expected to occur as a result of direct or indirect CBM development-related air pollutant emissions (including construction and operation).
- Operation emissions would occur due to natural gas-fired separator and dehydrator heaters, and increased compression requirements. It is anticipated additional field-wide compression would be approximately 42,500 HP (at 14 new compressor stations). Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2 or VOC emissions would occur.

- Potential direct atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas were also calculated. The maximum direct total (wet and dry) nitrogen deposition within these areas during operation were predicted to be nearly 0.009 kilograms per hectare-year (kg/ha-yr) and 0.007 kg/ha-yr, respectively; well below the 3 kg/ha-yr threshold). In addition, potential changes in Acid Neutralizing Capacity (ANC) at four lakes within the Weminuche Wilderness Area were all predicted to less than 0.8 per cent (calculated for Upper Grizzly Lake), well below the 10 per cent threshold for sensitive lakes.
- Potential direct visibility impacts were calculated based on observed relative humidity, as well as speciated aerosol concentrations measured between 1988 and 2002 at both Mesa Verde National Park and the Weminuche Wilderness Area. If the air quality impacts predicted under Alternative 1 - Industry Proposed Action had occurred during the observed visibility measurement period, a 1.0 deciview "just noticeable change" would not have been exceeded at Mesa Verde National Park on any day, and would have been exceeded between 0 and 3 days per year at the Weminuche Wilderness Area. However, given the "reasonable, but conservative" assumptions incorporated into this analysis, these direct impacts are not likely to occur.

Cumulative Effects

The cumulative impacts of CBM development are of concern. The general cumulative effects area is the Project Area (125,000 acres) and the area within the bounds of the Southern Ute Reservation that has and will continue to experience oil and gas development over the next decade (422,000 acres). The general cumulative effects area for most resource evaluations is therefore 547,000 acres. Air quality, economic, and social impacts, however, encompass a larger area that includes the New Mexico portion of the San Juan Basin.

In general, cumulative impacts over the larger geographic area would be as described above on a resource-by-resource basis. However, the geographic extent of impact is greater and would be more or less uniformly distributed across the entire cumulative effects area. The intensity and duration of impacts within the bounds of the Southern Ute Reservation and the Project Area would be the same.

The non-oil and gas impact of greatest concern is continued residential development within La Plata County. Residential development continues to fragment wildlife habitat and reduce wildlife habitat effectiveness. Continued CBM gas and residential development will also result in greater social conflict because of proximity of CBM development to residences, thereby resulting in increased visual and noise impacts, and possible property value impacts.

Air quality concerns are a function of existing and projected oil and gas development and other cumulative emission sources within the Colorado and New Mexico portions of the San Juan Basin. Although most of the predicted impacts are below significance thresholds, the USDI-National Park Service and USDA-Forest Service visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 9 to 21 days per year at the Weminuche Wilderness PSD mandatory federal Class I

area, and 14 to 31 days in the Mesa Verde PSD Class 1 Area. Combined Colorado and New Mexico federal mitigation efforts could reduce visibility impacts to between 2 to 15 days in the Weminuche Wilderness and 4 to 11 days in Mesa Verde National Park.

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Purpose and Need

Chapter 1 — Purpose of and Need for the Proposed Action

1.1 Introduction

Pure Resources, XTO Energy, Petrox Resources, Elm Ridge Resources, Exok, and British Petroleum ("the companies") propose to drill approximately 284 wells to produce natural gas from coal beds on federal, state, and privately owned lands in La Plata and Archuleta Counties, Colorado. The companies would also construct ancillary facilities needed to support the wells. The companies' proposal includes directional drilling to avoid steep slopes in portions of the HD Mountains where feasible.

1.2 Purpose and Need

Private industry exploration and development of federal oil and gas leases is an integral part of the U.S. Forest Service (FS) and Bureau of Land Management's (BLM's) oil and gas leasing program under the authority of the Mineral Leasing Act of 1920, as amended, the Mining and Mineral Policy Act of 1970, the Federal Land Policy and Management Act of 1976, the National Materials and Minerals Policy, Research, and Development Act of 1980, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987.

Exploration and production of natural gas, including methane gas from coal-bearing formations, is in accordance with the President's National Energy Policy, Executive Order 13212. The policy calls for federal agencies "to develop a national energy policy designed to help the private sector, and, as necessary and appropriate, State and local governments, promote dependable, affordable, and environmentally sound production and distribution of energy for the future." Natural gas is an integral part of the U.S. energy future due to its availability, the presence of an existing market delivery infrastructure, and the environmental advantages of clean burning gas.

The purpose of and need for this project is to allow the companies to drill to develop their federal oil and gas leases and to help meet the public's need for natural gas by increasing the number of wells that produce coal bed methane (CBM). The proposed CBM development would exercise the leaseholders' existing rights to drill for, extract, remove, and market gas products. National mineral leasing policies and the regulations by which they are enforced recognize the statutory right of leaseholders to develop federal mineral resources to meet continuing needs and economic demands so long as undue and unnecessary environmental degradation is not incurred. Also included is the right of the leaseholder within the Project Area to build and maintain necessary improvements, subject to renewal or extension of the leases in accordance with the proper authority.

This project would serve to meet the goals for management of energy minerals set forth in the Land and Resource Management Plan (LRMP) for the San Juan National Forest (FS 1983) and in the Resource Management Plan (RMP) for the San Juan/San Miguel Planning Area (BLM 1985).

1.3 Project Area

This environmental analysis of the companies' gas field development proposal focuses on a 125,000-acre Project Area in the Northern San Juan Basin (NSJB) of Colorado. The Project Area is that portion of the San Juan Basin north of the boundary of the Southern Ute Reservation, bounded on the south by the reservation and to the west, north, and east by the arcing line of the outcrop at the top of the Fruitland Formation.

The Project Area consists of 7,000 acres of BLM administered land, 49,000 acres of FS administered land, 9,000 acres of private lands with federal minerals, and 60,000 acres of state or privately held (fee) lands with non-federal minerals. The Project Area occupies portions of La Plata and Archuleta Counties (Figure 1–1).

1.4 Scope of Agency Decisions

This environmental impact statement (EIS) and its supporting project record are the basis for the Record of Decision (ROD) that will document the following BLM and FS decisions:

(1) Overall plan and conditions of development, including environmental protection measures that apply to the entire Project Area, or to portions of the area.

(2) Conditions under which ancillary facilities requested by the proponent may be constructed (including water and gas flowlines and compressor stations on FS or BLM lands).

(3) Conditions of approval specific to the approximately 54 pending surface use plans of operation (SUPOs) and applications for permit to drill (APDs) and related facility applications submitted by the companies, as shown on Figure 1–2.

(4) Whether to waive, allow an exception for, or modify the no surface occupancy stipulations issued May 14, 2001, on five leases within the Project Area, COC64932, COC64933, COC64934, COC64935, COC64936.

(5) Whether to continue or to terminate in whole or in part the Interim Criteria for development within the Project Area as described in Notice to Lessees (NTL) No. CO-SJFC-2000-01.

(6) Whether to amend the San Juan National Forest Land and Resource Management Plan to achieve Plan conformance for old growth and transportation system management in winter range, depending on the alternative selected.

These decisions will incorporate the terms and mitigation requirements that the agencies deem necessary to protect the surface and sub-surface resources based on disclosure of environmental effects in this EIS for CBM gas field development.

These approvals are contingent on decisions regarding:

(1) How the companies' drilling plans can be carried out in accordance with the stipulations set forth in the leases and in applicable federal laws;

(2) To the extent consistent with the rights conveyed with the leases, whether the APDs and SUPOs are consistent with current BLM and FS policies, regulations, and the approved LRMP and RMP;

(3) Whether the SUPOs meet or exceed the surface use requirements of FS regulation codified at Title 36 Code of Federal Regulations (CFR) Part 228.108 and the BLM regulation at 43 CFR 3162.5–1; and

(4) Whether the surface use plans are acceptable to the authorized Forest Officer based on review of the environmental consequences of the operations.

Project decisions will be documented in a ROD signed by the BLM and FS responsible officials and will apply to federal lands and minerals only. The private mineral estate is under the administrative jurisdiction of the Colorado Oil and Gas Conservation Commission (COGCC) and is not subject to the decisions documented in the ROD for this proposal. Decisions by other jurisdictions to issue (or not to issue) gas development approvals may be aided by the disclosure of impacts that is available in this analysis.

This EIS addresses the environmental effects of developing CBM within the Project Area. It discloses built-in environmental protection measures (called project design features) applicable to all alternatives. It also proposes mitigation measures that apply to all or portions of the Project Area and to CBM development overall. Site-specific environmental protection measures are designed to control the impacts of the project.

The analysis evaluates specific proposed locations and proposed construction, operational, and decommissioning plans for components of the proposed action that are described in an APD, right-of-way (ROW) application, or special use permit (SUP) application. These plans apply to the wells, roads, pipelines, and ancillary facilities on federal mineral estate. Final locations for facilities will be confirmed as part of the normal processes for approving APDs, ROWs, or SUPs. The agencies' decisions made when the EIS process is complete will apply to construction, operation, and decommissioning of facilities that are on federal lands and mineral estate.

1.5 Scope of Analysis for Well Sites

The 66 current pending APDs and SUPOs the companies have submitted in conjunction with their CBM gas field development plans are analyzed on a site-specific basis in this EIS (Figure 1–2). Decisions regarding these applications will be addressed in the ROD for this project.

The companies have not submitted APDs for all their proposed well sites within the Project Area to date. We project that the companies will submit 30 to 40 APDs per year for their gas field development proposal. When submitted, the National Environmental Policy Act (NEPA) review of each of these APDs will

be tiered to this EIS. The review will be limited in scope in each case to the site-specific aspects of the environmental analysis that are not covered by this EIS.

This will involve field review of specific well, access road, and flowline locations. The agencies will conduct site surveys consistent with specific requirements for protection of cultural and historical resources. Field surveys will also evaluate compliance with the Endangered Species Act (ESA) and with the construction, operation, and mitigation requirements set forth in the ROD for this project proposal. The surface use requirements in Appendix A of the EIS will be modified as needed to address additional environmental concerns that may result from the field survey and final well and access road siting.

1.6 Context for Oil and Gas Leasing and Development

The BLM manages public lands, and FS administers national forests and national grasslands. The policies that control how these lands will be administered have their basis in a number of federal statutes. The sections below describe some of the important laws that apply to oil and gas development, and the regulations that codify the statutes. Lease information pertinent to the Project Area is shown on Figure 1–3 and described in Appendix B.

1.6.1 Land and Resource Management Plans

The management plans for the San Juan Field Office of the BLM and San Juan National Forest (SJNF) both call for multiple use and sustained yield of the federal lands. The LRMP for the SJNF (FS 1983) provides long-range management direction for National Forest System (NFS) lands in the Project Area. The LRMP also specifies the management requirements that set the baseline conditions that must be maintained and the mitigation measures that apply to all areas of the SJNF. Development of oil and gas must be consistent with the LRMP.

The RMP for the San Juan Field Office of the BLM serves the same purpose as the LRMP for the SJNF. It establishes management requirements and mitigation measures that apply to all areas under the jurisdiction of the Field Office. The RMP for the San Juan Field Office was approved in 1984, and the provisions of the plan on oil and gas leasing and development were amended in 1991. Management of BLM public lands within the Project Area must be consistent with the San Juan Resource Management Area RMP. This gas field development EIS is tiered to both the SJNF's LRMP and BLM's RMP.

1.6.2 Mineral Leasing Act

The 1920 Mineral Leasing Act (MLA), as amended, authorizes the Secretary of the Interior to competitively lease the oil and gas resources on all public domain and acquired lands. The MLA implementing regulations are at 43 CFR 3100.

1.6.3 Federal Onshore Oil and Gas Leasing Reform Act

The Federal Onshore Oil and Gas Leasing Reform Act (Public Law [P.L.] 100–203) provides direction for each agency 1) to manage a leasing program for oil and gas and 2) to manage oil and gas operations on leases once they are issued. Oil and gas leasing and development are managed in a staged process that requires separate decisions at the leasing and development stages. This staged process is consistent with the staged decision-making framework established for development and implementation of LRMPs and RMPs. The proposal under consideration in this environmental analysis is in the development stage.

The BLM manages all federally owned subsurface minerals. In the case of oil and gas on NFS lands, it is responsible for APD approval and for monitoring subsurface activities related to exploration and development. BLM's monitoring role includes administering all federal regulations that pertain to subsurface oil and gas, regardless of the agency that administers the surface resources. The BLM regulations are found in Title 43 CFR Part 3160.

The FS has the authority and responsibility for approving SUPOs prepared by the lessee, and for ensuring that the requirements of the leases and operating plans are carried out according to their terms. The FS regulations are found in Title 36 CFR Part 228.

The required review of APDs and SUPOs provides the analytic basis that the decision-maker(s) will use to establish the terms and conditions of approval for operations on the public lands and national forests. This decision is site-specific or project-level rather than programmatic and is the last of the staged decisions that constitute the process of oil and gas leasing and development on the BLM and FS lands.

1.6.4 National Environmental Policy Act

The BLM and FS (joint lead agencies for this project) are required by NEPA and Council on Environmental Quality (CEQ) directives to analyze proposed actions that involve federal lands in terms of their potential impact on the human environment (40 CFR Parts 1500–1508). This EIS fulfills the requirements of NEPA and provides the responsible agency officials with information that can be used to support a final decision that is fully informed and that considers all factors relevant to the proposal. Public and agency scoping issues and concerns drive the development of alternatives and the impact analysis process. This EIS documents (1) the analysis of impacts that result from implementation of the proposed action and alternatives, and (2) the development of environmental protection measures necessary to reduce or eliminate environmental consequences.

Factors incorporated in the environmental analysis process for this proposed CBM project include the following:

- The location of well sites, access roads, pipelines, electrical distribution lines, compressor facilities, and produced water disposal facilities reflects an initial attempt to minimize impacts to surface resources and to meet the

needs of other resource activities while honoring the lease rights within the Project Area.

- Impacts anticipated to result from implementation of the proposed action and alternatives are determined in accordance with applicable regulations and lease stipulations and mitigation measures necessary to avoid or minimize these impacts.

1.7 Status of Gas Field Development to Date

1.7.1 Development on the SJNF

To date, the companies have developed 32 wells on the SJNF, primarily in the Sauls Creek area of the HD Mountains, at a density of one well per 320-acre spacing unit. The BLM recently (May 2000) approved spacing of two wells per 320 acres on FS lands within the La Plata County portion of the Project Area. Development of the Pargin Mountain area of the HD Mountains has been limited to five wells, completed in 1992 and 1993.

1.7.2 Development on BLM Administered Public Land

The companies, to date, have developed 23 wells on BLM leases, most at a density of one well per 320-acre spacing unit. Seven wells have been developed at an increased well density of two wells per 320 acres. The BLM in May 2000 approved spacing of two wells per 320-acre spacing unit on most BLM leases in the Project Area.

1.7.3 Development on Private and State Land

Currently, 231 wells are developed on private and state leases throughout the Project Area. About half of this development is at spacing of two wells per 320 acres, and the remainder is at one well per 320 acres. Private and state leases are subject to COGCC spacing order No. 112–157, which provides for development of the Fruitland Formation at a density of two wells per 320 acres.

1.8 Interim Criteria for CBM Development During the EIS Process

The BLM and FS have issued Interim Criteria as a Notice to Lessees to guide management of CBM production on public lands until completion of this NSJB CBM EIS. The interim criteria are intended to allow for limited development of mineral resources if it does not preclude options under the EIS. These guidelines also allow decision-makers and technical staff to further study the effects of CBM development, especially with respect to methane seepage and water depletion issues. Environmental impacts are addressed on a case-by-case basis in individual environmental analyses. Drilling in sensitive areas may be curtailed, and other areas may be subject to special stipulations and monitoring.

Within the Project Area, there are three regions that have established interim criteria. These regions include (1) the Fruitland Outcrop and a line 1½ miles basinward of the Fruitland Outcrop buffer north of the Southern Ute line, (2) the area between the 1½-mile buffer zone and the northern line of the Southern Ute Reservation, and (3) the National Forest lands east of Bayfield. Criteria for each region are as follows:

- Fruitland Outcrop and buffer zone north of the Southern Ute line: No drilling within 1½ miles down-basin from the outcrop until the NSJB EIS is completed, and an ROD on infill drilling can be supported within the EIS framework. Prior to this, the 3M modeling results (ground water study) will be available to support the ROD. (Exception: Drilling of monitoring and experimental wells will be allowed).
- Fruitland Outcrop and buffer zone south of the Southern Ute Reservation: Within this zone, the BLM will continue to process APDs on a case-by-case basis utilizing all available information, including the 3M modeling studies.
- National Forest lands east of Bayfield: Current NEPA documents address specific drilling windows on 320-acre spacing, but do not provide for infill drilling. The FS holds that, until the NSJB EIS is completed and an ROD issued, infill drilling will be delayed. However, existing 320-acre spacing units may be drilled.

The complete text of the Interim Criteria is included in NTL No. CO–SJFC–2000–01. The results of 3M modeling (the ground water study) are incorporated in this EIS, and the 3M Study along with other information disclosed in this EIS will form the basis for the ROD, continuing, or terminating, in whole or part, the CBM development direction presented by the Interim Criteria.

1.9 Public Involvement

During 2000, the public had the opportunity to present issues and concerns regarding CBM development at forums sponsored by both the COGCC and La Plata County. These well-attended forums are considered key components of the overall public involvement strategy and the information presented at these forums was captured as critical public input to this project. Following the COGCC and La Plata County hearings, the BLM and FS conducted two rounds of informational open houses to build on the previous public involvement efforts and to present and receive information specific to the EIS for the NSJB.

Public scoping for this EIS formally began on April 4, 2000, after a Notice of Intent (NOI) to prepare an EIS was published in the *Federal Register*. The notice (volume 65, number 65, page 17,672) announced the BLM and FS intent to conduct an environmental analysis of CBM development in the NSJB of southwestern Colorado, and set May 16 and 17, 2000 as the dates for public meetings to solicit and receive comments on the proposed CBM development. The agencies published a second NOI in the *Federal Register* on June 9, 2000 (which appeared in volume 65, number 112, on page 36,713) that announced a change in dates for the public meetings from May 16 and 17, 2000 to June 28, 2000 in Durango, and

June 29, 2000 in Bayfield. The notice also extended the deadline for submitting written comments from June 1, 2000, to July 14, 2000. Copies of both NOIs published are included as Appendix C.

The public meetings were structured to discuss the companies' proposed CBM development and to receive comments from the public. Meetings were conducted in the open-house style, with representatives of the BLM, FS, La Plata County Planning Department, and the companies in attendance to provide handouts, answer questions, and solicit comments from the attendees.

During October 2001, the companies submitted a revised proposal that increased the number of CBM wells from 170 to approximately 300 new CBM wells. On January 16 and 17, 2002, a second round of public meetings was held in Durango and Bayfield to update the public on the revised proposed action and the alternatives to be described in the EIS. The overall scoping and issues compilation process generated 20 primary issue statements. Three of these statements concerned the need to develop effective mitigation measures, the geographic extent of the Project Area, and the need to address cumulative impacts of CBM development. These process issues are addressed by the purpose and scope of this EIS.

The BLM and FS released the draft EIS on June 10, 2004 and took public comments until November 30, 2004. During the comment period, the BLM and FS conducted one public hearing, four open houses, and four additional public forums sponsored by the BLM Southwest Resource Advisory Council.

The FS and BLM received 68,044 comment responses—including letters, emails, and faxes—approximately 1,396 of which contain original comments. A total of 4,505 individual comments were coded and attributed to 412 public concerns; 66,545 responses are form letters, defined as five or more letters of identical text submitted by different people. The comment analysis and responses provided in this document are based on the 1,396 original comment responses and the one example of each form letter. The remaining 103 responses account for sign-in sheets, 39 duplicate letters, and 63 out-of-scope responses. The complete set of comments is on file at the San Juan Public Lands Center. Government and Tribal comments are reproduced in whole in Appendix O. Comment themes in the form of public concern statements and their various facets and comment responses are included as Appendix O.

Every comment received is considered for its substance and contribution to informed decision-making, whether it is one comment repeated by tens of thousands of people or a comment submitted by only one person. The emphasis when reviewing public comment is on the content of the comment rather than on the number of times a comment was received. The comment analysis process is intended to identify unique substantive comments relative to the proposal to facilitate public consideration in the decision-making process. All comments are considered, including comments that support and that oppose the proposal. The public comment process provides a vital avenue for engaging a wide array of the public in resource management processes and outcomes. We have modified and expanded portions of the EIS in response to comments.

The following environmental, social, and economic issues are addressed throughout the remainder of the EIS. Additional CBM development will affect:

(1) ground water resources, including aquifers and water wells;

(2) surface water resources;

(3) human health and safety;

(4) the socioeconomic environment;

(5) the area's geologic, paleontologic, and mineral resources;

(6) wildlife and fisheries and their habitats;

(7) agricultural and residential use;

(8) vegetation, including wetlands and riparian areas and old-growth ecosystems;

(9) the area's scenic values;

(10) air quality and visibility;

(11) area noise;

(12) transportation and roads;

(13) cultural resources and Native Americans;

(14) recreational opportunities;

(15) soils in and downstream of the Project Area;

(16) federal and state listed threatened, endangered, proposed, candidate, and sensitive species and their habitats; and

(17) the HD Mountains inventoried roadless area and roadless lands in general.

1.10 Authorizing Actions

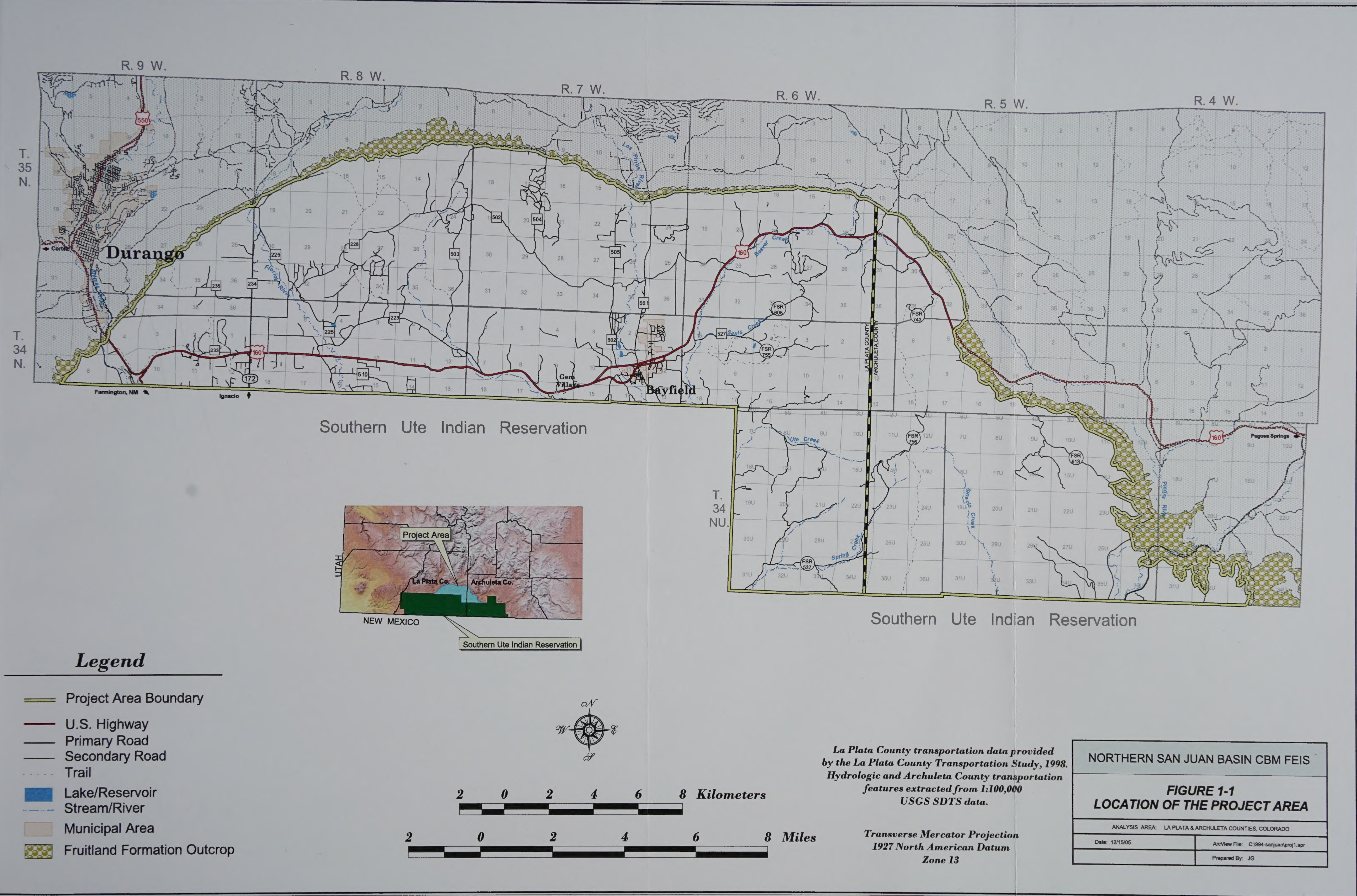
Other federal, state, county, and local entities require the companies to obtain a variety of permits before the companies can proceed with certain actions related to oil and gas exploration and development. Table 1-1 lists the major federal and state permits, approvals, and consultations that the companies may be required to obtain. The list is not necessarily comprehensive. In addition, the companies may need to obtain various county and local permits and approvals before implementing actions on private lands.

Table 1-1 Major Federal, State, and County Authorizing Actions

Agency and Permit or Approval	Nature of Action	Authority
Federal Permits, Approvals, and Authorizing Actions		
Bureau of Land Management		
Record of Decision for Preferred Alternative	Evaluates environmental impacts of Preferred Alternative	National Environmental Policy Act of 1969, 42 United States Code (USC) 432.1 et seq. Council on Environmental Quality, 40 CFR 1501, 1502
Application for Permit to Drill, Deepen, or Plug Back (APD)	Provides for compliance with regulations and requirements during the drilling and completion phase of the well	Mineral Leasing Act of 1920 (30 USC 181 et seq.); Federal Oil and Gas Royalty Management Act of 1982, 43 CFR 3160 series, subparts 3160.0-1 Purpose, 3160.0-1 Authority, and 3161.1 Jurisdiction; Secretarial order NO. 3087, Amendment No. 1, February 7, 1983; Indian Mineral Development Act of 1982, 43 CFR 3160.0-3
Special Use Permit	Surface disturbance on BLM administered lands	
U.S. Forest Service		
Record of Decision for Preferred Alternative	Evaluates environmental impacts of Preferred Alternative	National Environmental Policy Act of 1969, 42 USC 432.1 et seq. Council on Environmental Quality, 40 CFR 1501, 1502
Surface Use Plan of Operation	Occupancy or use of FS leased lands in conjunction with all oil and gas operations	Authority is Mineral Leasing Act as amended by the Federal onshore Oil and Gas Leasing Reform Act.
Special Use Permit	Surface disturbance on FS lands	
Special Use Permit (Cultural Resources)	Archaeological surveys and testing on FS lands. Data recovery of sites on FS lands	
Timber Sales Contract	Accounts for timber, cut or affected, during mineral-related activities	National Forest Management Act of 1976.
U.S. Fish and Wildlife Service		
Consultation process, endangered or threatened species	Reviews impact on federally listed and candidate threatened and endangered fish, wildlife, and plant species	Section 7 of the Endangered Species Act of 1973, as amended (16 USC Sec. 1344), 33 CFR 323, 325
Advisory Council on Historic Preservation		
Consultation on cultural and historic resources	Protects cultural and historic resources. Coordinated with the Colorado State Historic Preservation Officer (SHPO)	National Historic Preservation Act Section 106 and 36 CFR 800
U.S. Army Corps of Engineers		
Permit to Discharge Dredged or Fill Material (Section 404 Permit)	Authorizes placement of dredged or fill material in waters of the United States or adjacent wetlands	Section 404, Clean Water Act, 40 CFR 122-123; 33 CFR 323 and 325
U.S. Environmental Protection Agency		
Permit to allow underground injection of produced water	Drilling of wells for the disposal of water produced from the CBM wells	Safe Drinking Water Act, 40 CFR 144 and 147

Table 1-1 Major Federal, State, and County Authorizing Actions

Agency and Permit or Approval	Nature of Action	Authority
U.S. Department of Transportation		
Sets standards for the construction and operation of natural gas pipelines	Prescribes minimum safety requirements for pipeline facilities and the transportation of gas	49 CFR 191
State Permits, Approvals, and Authorizing Actions		
Colorado State Historic Preservation Office		
Archaeological consultation	Archaeological Clearance. Programmatic agreement or consultation for cultural inventory, evaluation, and mitigation	National Historic Preservation Act Section 106 and 36 CFR 800
Colorado Department of Public Health and Environment		
Air Pollutant Emissions Notice and Construction/Operation Permit	Issue a permit that limits emissions from new or modified sources	Colorado Revised Statutes (CRS) 25-7-110 et al.
Stormwater Permit	Issue a permit to regulate discharge of stormwater	Clean Water Act, 40 CFR 401; Colorado Water Quality Control Act 25-8-101
Colorado Department of Transportation		
Permit for oversize, overlength, and overweight loads	Transportation of equipment over state roads	CRS 42-4-409
Permit for right-of-way easement crossing state highways	Construction of new roads connecting to state roads	CRS 43-1-105
Colorado Oil and Gas Conservation Commission		
Permit to Drill, Deepen, or Re-enter and Operate an Oil or Gas well	State approval for drilling on non-federal lands	CRS 34-60
County Permits, Approvals and Authorizing Actions		
La Plata County		
Permit for surface facilities	Issue a permit for surface facilities on private lands not connected with downhole operation	La Plata County land Development Code
Permit for overweight and overlength vehicles	Transportation of equipment over state roads	La Plata County Land Development Code
Permit for new roads crossing county roads	Construction of new roads connecting to state roads	La Plata County Land Development Code
Archuleta County		
Conditional Use Application	Permit needed to construct major oil and gas facility	Archuleta County Land Use Regulations, Section 11 and Appendices E and F


R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
T. 35 N.
T. 34 N.
T. 34 NU.
Durango
Bayfield
Gem Village
Farmington, NM
Ignacio
Cortez
Pagosa Springs
LA PLATA COUNTY
ARCHULETA COUNTY
Southern Ute Indian Reservation
Southern Ute Indian Reservation
Project Area
UTAH
NEW MEXICO
La Plata Co.
Archuleta Co.
Southern Ute Indian Reservation
Legend
Project Area Boundary
U.S. Highway
Primary Road
Secondary Road
Trail
Lake/Reservoir
Stream/River
Municipal Area
Fruitland Formation Outcrop
2 0 2 4 6 8 Kilometers
2 0 2 4 6 8 Miles
La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data.
Transverse Mercator Projection
1927 North American Datum
Zone 13
NORTHERN SAN JUAN BASIN CBM FEIS
FIGURE 1-1
LOCATION OF THE PROJECT AREA
ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO
Date: 12/15/05
ArcView File: C:\994-sanjuan\proj1.apr
Prepared By: JG

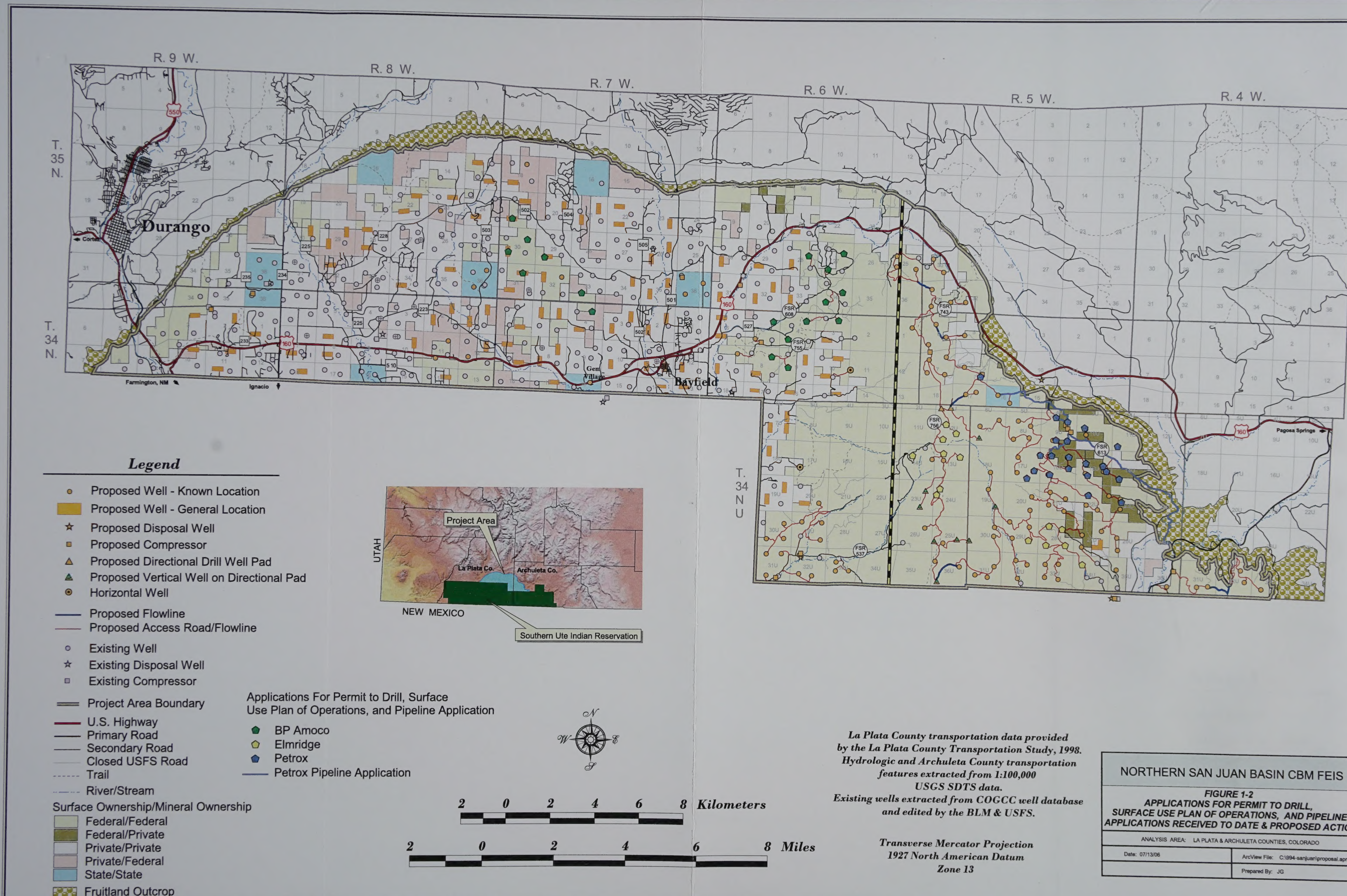
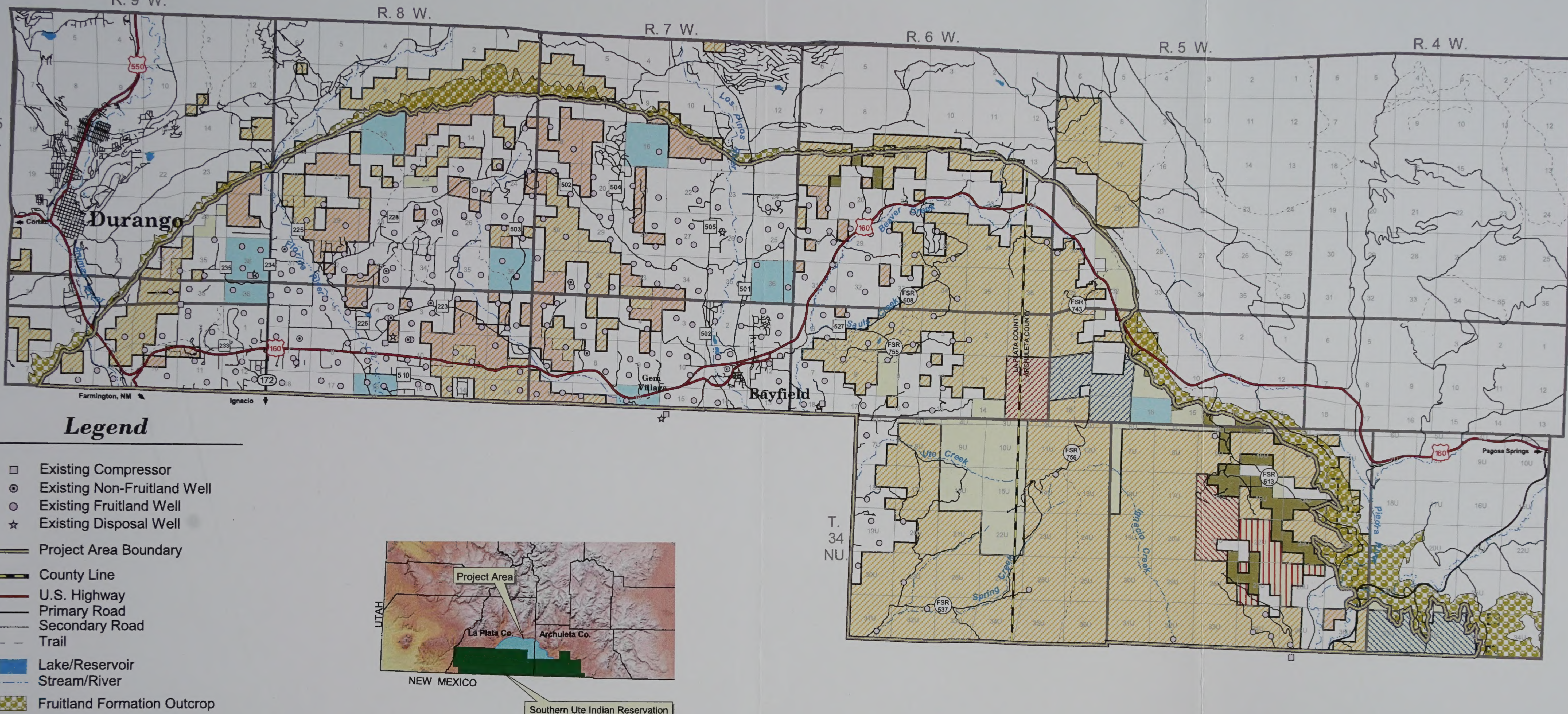


FIGURE 1-2
APPLICATIONS FOR PERMIT TO DRILL, SURFACE USE PLAN OF OPERATIONS, AND PIPELINE APPLICATIONS RECEIVED TO DATE & PROPOSED ACTION



Legend

- □ Existing Compressor
- ⊙ Existing Non-Fruitland Well
- ○ Existing Fruitland Well
- ☆ Existing Disposal Well
- Project Area Boundary
- County Line
- U.S. Highway
- Primary Road
- Secondary Road
- Trail
- Lake/Reservoir
- Stream/River
- Fruitland Formation Outcrop

Federal Leases as of April 23, 2003

- Federal Lease
- Federal Lease COC 64934 With No Surface Occupancy Stipulations
- Federal Lease COC 64933 With No Surface Occupancy Stipulations
- Federal Lease COC 64932 With No Surface Occupancy Stipulations
- Federal Lease COC 64936 in Roadless Area - Post 01/12/2001 With No Surface Occupancy Stipulations
- Federal Lease COC 64935 in Roadless Area - Post 01/12/2001 With No Surface Occupancy Stipulations

Surface/Mineral Ownership

- Federal Surface/Federal Mineral
- Federal Surface/Private Mineral
- Private Surface/Private Mineral
- Private Surface/Federal Mineral
- State Surface/State Mineral

N W E S

2 0 2 4 6 8 Kilometers

2 0 2 4 6 8 Miles

La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data. Existing wells extracted from COGCC well database and edited by the BLM & USFS. Federal lease data provided by the USFS.

Transverse Mercator Projection
1927 North American Datum
Zone 13

NORTHERN SAN JUAN BASIN CBM FEIS	
FIGURE 1-3 PROJECT AREA LEASE STATUS	
ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO	
Date: 06/09/06	ArcView File: C:\994-sanjuan\proj1.apr
	Prepared By: JG

Chapter 2
Proposed Action and Alternatives

Chapter 2 — Proposed Action and Alternatives

This chapter presents five alternatives, including the no action alternative and the proposed action, analyzed in detail, along with five alternatives dismissed from detailed consideration. The chapter is divided into six major sections:

- Background information key to understanding the alternatives.
- Process used to develop the alternatives.
- Alternatives analyzed in detail.
- Alternatives dismissed from detailed consideration.
- Well field development activities common to the alternatives.
- Comparative analysis of environmental consequences of the alternatives.

2.1 Summary of Changes between Draft and Final EIS

We have revised or expanded several sections of Chapter 2 in response to comments on the draft EIS (DEIS). The following summarizes the changes. Details of each alternative are covered in Section 2.3.

2.1.1 Alternative 1

Alternative 1 is the CBM gas development proposal. One company has modified its CBM gas development plan by eliminating 15 proposed wells located within close proximity to the Fruitland outcrop in the eastern Project Area and by submitting a proposal to develop a gas and water pipeline system along Fosset Gulch Road in the eastern Project Area. Another company proposes to drill two horizontal wells in the HD Mountains that were not contemplated in the DEIS. This change in the overall number of wells and pipelines the companies propose causes us to modify Alternative 1 in the final EIS (FEIS) to reflect the changes (Table 2-1).

2.1.2 Alternatives 1A and 1B

Alternatives 1A and 1B were both developed and analyzed in detail in the DEIS to examine how CBM gas development could proceed if short- and long-reach horizontal drilling were feasible and utilized to the maximum extent. The two alternatives' purpose was to examine a way in which surface impacts could be reduced while still draining the same federal lease area as proposed by the companies (Alternative 1). In practical terms, the drilling and development technologies depicted by the two alternatives can be applied to any of the alternatives considered in detail if their technical and economic feasibility is established. We

have chosen not to bring Alternatives 1A and 1B into the FEIS, but consider features of the alternatives as elements that may be adopted in the ROD and in subsequent decision making that would apply to individual wells or development zones in the HD Mountains. Facets of these two alternatives are portrayed in Alternative 6, which has been developed for the FEIS.

2.1.3 Alternatives 3 and 4

Alternative 3 in the DEIS involved reducing the number of wells in the HD Mountains Roadless Area from those in the proposed action (Alternative 1). Alternative 4 was consistent with the 1992 CBM development plan for the HD Mountains. These two alternatives are not brought into the FEIS because they duplicate many of the features incorporated in Alternatives 6 and 7, which were developed in response to comments.

2.1.4 Alternative 6 — (New)

A number of commentors, including the county commissions of both La Plata and Archuleta Counties, and the town councils of Bayfield, Ignacio, and Durango, requested that the BLM and FS not permit surface facilities within the HD Mountains Roadless Area and either not permit or defer drilling within the 1½-mile buffer zone for the Fruitland Formation outcrop. We have developed Alternative 6 in response to these comments. Under Alternative 6, natural gas resources in the HD Mountains Roadless Area would be developed from surface locations outside the boundaries of the roadless area with the use of directional drilling. No federal wells would be developed within the 1½-mile outcrop zone for the Fruitland Formation. Alternative 6's implementation can result in a range of potential outcomes regarding CBM gas resource development of the Roadless Area ranging from drilling successful wells from the Area's perimeter to drilling no wells because of a failure of the horizontal drilling technology. (See Appendix D for further analysis of horizontal drilling.) For the purpose of impact analysis, we assume that horizontal wells will be drilled.

2.1.5 Alternative 7 — Preferred Alternative (New)

Alternative 7 was also developed in response to comments and concerns regarding CBM gas development impacts. Alternative 7 is different from the Proposed Action in the following ways:

Three areas of proposed development in the HD Mountains where access roads overlay areas with high potential for landslides and mass wasting (Figure 2–6, Zones 1 through 3) are not included in the Project Area in Alternative 7. Decisions for actions on federal leases in these areas will be considered when the companies submit site-specific proposals, supported by engineered designs, for those three areas.

Also under Alternative 7, CBM development within the 1½-mile buffer zone for the Fruitland Formation outcrop in the Fosset Gulch Federal Unit would proceed in a stepwise fashion. Approximately 14 wells mostly on private minerals estate underlying federal surface in T.33N, R.5 W., Sections 9U, 10U, 15U, 16U, 22U,

and 23U would be drilled first. This clustered development would be monitored according to current state requirements for well performance, well interference, water production, and effects to domestic water wells, springs seeps, and the Fruitland outcrop (Section 3.3.10). If monitoring data from these wells indicate identifiable and measurable undesirable effects from production on other production wells, nearby water wells, springs, seeps, and the outcrop, then subsequent wells may be conditioned to prevent or minimize additional or exacerbated effects. This stepwise approach to the development of the near outcrop zone (¾ miles to 1½ miles) in the eastern Project Area would allow the orderly collection of important production data that would aid in future APD approvals.

2.2 Background Information Key to Understanding the Alternatives

This section discusses well spacing orders and drilling methods that are key to understanding all alternatives. It also presents the assumptions used in analyzing the alternatives.

2.2.1 Well Spacing Orders

BLM (May 3, 2000) and COGCC (Order No. 112–156) issued orders in 2000 that effectively increased the permissible densities of wells by amending previous orders that allowed one well per 320-acre spacing unit. These new orders allow two wells per 320-acre spacing unit for the coal seam in the Fruitland Formation in the La Plata County portion of the Project Area. This well density promotes optimum drainage and recovery of the natural gas resource in the western portion of the Project Area.

The orders also define boundaries and setbacks within each quarter section, which appear as windows of about 27 acres when they are delineated on a map. Wells are situated within the windows to provide adequate spacing between wells and to promote efficient drainage of the gas field.

Current spacing in Archuleta County remains one well per 320-acre unit. Two companies have unitized leases (a method of coordinated development aimed at protecting drainage of the resource) within Archuleta County in the eastern portion of the Project Area. The unitized leases could allow for up to four wells per section if this density of wells is deemed optimum from a drainage standpoint.

Open, undrilled drilling windows, especially in the western portion of the Project Area, can encompass both private and federal ownership. Thus, the option exists for the companies to situate a well on either private or federal surface ownership within the 27-acre drilling window. A total of 24 drilling windows encompass lands with some combination of federal and private ownership where the actual location of a well within the 27-acre window has not been selected at this time. These wells would be sited when a company submits an APD.

2.2.2 Alternative Drilling Methods

Alternative drilling methods considered in this EIS include directional and horizontal methods. Directional drilling is typically used when terrain features or fragile resources prevent or discourage a company from occupying the surface directly above the target down-hole location. When the companies drill directionally, they move to another location and drill back at an angle, instead of vertically, underground to the target area. Thus, the surface well is offset from the down-hole target.

Alternatives 1, 2, 6, and 7 utilize directional drilling. Directional drilling is feasible in areas where there is sufficient distance between the surface location and subsurface target to accommodate the necessary well bore curvature. Directional drilling deviation from vertical is typically 20 to 22 degrees and requires at least the first 300 feet of depth to be drilled vertically to accommodate the surface casing. An angle of 20 degrees of departure allows for 35 feet of offset for each 100 feet of depth drilled. Directional drilling is thought to be technically and economically feasible in the highest elevations of the HD Mountains because the distance between the ground surface and the target Fruitland Formation (4,000 feet) is sufficient to allow offsets from surface locations to targeted subsurface locations in the coal reservoirs. Directional drilling has been considered at locations other than the crest of the HDs within the Project Area, but does not appear feasible because of lack of depth to the target Fruitland Formation. Figure 2–1 displays distance from the surface to Fruitland coals.

Horizontal drilling is a subset of the more general term "directional drilling" used where the departure of the well bore from vertical exceeds about 80 degrees. Horizontal drilling can be utilized in situations where the depth to coals is not sufficient to allow conventional directional drilling. Short-reach horizontal drilling provides maximum horizontal displacement of 1,800 feet from the wellhead and long-reach horizontal drilling provides a maximum horizontal displacement of about 4,000 feet from the wellhead. Both drilling approaches were considered in the formulation of alternatives. Horizontal drilling has seen limited application in the San Juan Basin (SJB) to date and has met with mixed success. The drilling method is examined in the EIS as a way to access Fruitland Formation coal beds in the Roadless Area and to reduce surface impacts if its effectiveness is demonstrated in the Fruitland coals. Appendix D provides a more comprehensive description of the drilling technologies and their use in the SJB.

2.2.3 Assumptions Used in Analyzing the Alternatives

The alternatives present both specific proposed well locations and 27-acre drilling windows where the exact locations of the wells have not been identified through field siting. Surface and mineral ownership are identified where well locations are known within the drilling windows. The well is assigned a jurisdiction where the well location is not known but is within a drilling window that encompasses more than one jurisdiction by using the geographic center of the window as the assumed location.

Assumptions are made about the amount of road construction required to access windows where precise well locations have not been established. In the western portion of the Project Area, the assumed lengths of access road and pipelines needed to access each well pad is ¼ mile for private and state-owned lands, ⅓ mile for lands administered by BLM, and ½ mile for NFS lands (Bell 2002a). A conceptual network of roads has been laid out and more precisely measured on NFS lands in the eastern portion of the Project Area. The access roads and gathering pipelines for gas and produced water would require a 40-foot cleared ROW during construction and a 25-foot cleared ROW after partial reclamation following construction.

The Fruitland Formation is the target horizon for all wells that comprise the proposed action. In addition, one company proposes to test the Mesa Verde and Pictured Cliffs formations. These exploratory wells would utilize Fruitland formation well pads.

2.2.4 Project Area and Cumulative Effects Area

The alternatives are framed around CBM development of federal oil and gas leases. Allowing development of federal oil and gas leases constitutes the federal action that is the subject of agency analysis in this EIS. The FS and BLM have no regulatory influence over how and when CBM development would proceed on private and state mineral leases within the Project Area. However, the Agencies are required by NEPA to analyze foreseeable development of private and State lands in the Project Area for cumulative effects. The 125,000-acre study area is treated as a comprehensive project from which the environmental effects of CBM development in the NSJB are evaluated in detail. This EIS thus presents the local counties and the State of Colorado an impact analysis that aids in local, non-federal decision-making.

A larger cumulative effects area is also investigated. The cumulative effects area is determined by how far in time and space the effects continue to contribute to the cumulative effects. This area, described in detail in Chapter 3, encompasses the Colorado portion of the SJB. The analysis considers, in addition to the Project Area, projected conventional and CBM gas development within the bounds of the Southern Ute Reservation. The air and social and economic impacts are more far-reaching. Consequently, their analyses extend into New Mexico, addressing energy development within the SJB proper, including development within the BLM Farmington Resource Area and Jicarilla Ranger District, Carson National Forest.

2.3 Detailed Alternative Descriptions

The alternatives to the proposed action were designed to respond to issues identified through scoping and in response to public comments. The no action alternative is required under 40 CFR 1502.14. The alternatives cover development possibilities that range from no development on federal oil and gas leases to maximum development of all leased lands within the Project Area.

A number of alternatives have also been eliminated from detailed consideration. These alternatives and the rationale for their exclusion are discussed in Section 2.4 (beginning on page 2–15).

Five alternatives are analyzed in detail in the FEIS. Thematically, they represent the Proposed Action (Alternative 1), Maximum Development (Alternative 2), BLM and FS modifications of the Proposed Action (Alternatives 6 and 7), and the No Action Alternative (Alternative 5). Analysis of each of the alternatives considers the federal action, which is development of federal oil and gas leases within the Project Area, and also development on other jurisdictions, including private and state leases within the Project Area.

2.3.1 Alternative 1 — Proposed Action

Alternative 1 is the CBM development proposal. The federal action that is the subject of federal decision-making under Alternative 1 would be to permit drilling of and subsequent production from 185 wells located on 162 well pads on federal oil and gas leases in the Project Area (Table 2-1). Concurrent with Fruitland Formation drilling, there would be a limited number of test wells drilled to the Mesa Verde and Dakota sandstones utilizing Fruitland well pads. Drilling on federal leases would be at a density of four wells per section.

The proposal includes directionally drilling of 25 wells on National Forest in the high elevation portion of the HD Mountains (Figure 2–2). Well pads for directional drilling are larger than well pads for single vertical wells. The 15 multi-well pads that would be needed for directional wells under Alternative 1 are located in the eastern half of T34N, R6W.

The proposal also includes construction of an estimated 97 miles of collocated access roads and gathering lines, one disposal wells, 7 compressor units, and approximately 6 miles of gas trunk line on federal mineral leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate and the amount of direct surface disturbance for Alternative 1 are presented on Table 2-1.

The no-surface occupancy stipulations attached to lease numbers COC64932, COC64933, COC64934, COC64935, and COC64936 would be waived and surface occupancy of these three leases assumed.

In the eastern portion of the Project Area, the proposal includes disposal of produced water through a combination of truck hauling and deep injection at disposal wells. One disposal well may be constructed on national forest as shown in Figure 2–2.

New gas compression facilities would consist of 33 natural-gas-fired compressor units distributed across 12 compressor stations. Multiple compressor units may be located at one compressor station. The 14 new compressor sites would add 42,500 horsepower of compression to the Project Area (Table 2-2).

Table 2-1 Summary of Proposed Wells and Ancillary Facilities on Federal Mineral Estate under Alternative 1 — the Proposed Action

		Direct Ground Disturbance[1]	
Facility	Number	Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	12	NA[2]	NA
Private Surface/Federal Minerals	15	NA	NA
National Forest System(fed min)	158	NA	NA
Total	185	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	12	17	12
Private Surface/Federal Minerals	15	21	15
National Forest System(fed min)	135	197	144
Total	162	235	171
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	4	19	9
Private Surface/Federal Minerals	5	23	12
National Forest System(fed min)	88	436	272
Total	97	478	293
Pipelines (total length in miles)[3]			
BLM Lands	0	0	0
National Forest System Lands	4	23	0
Total	4	23	0
Produced Water Disposal Wells			
BLM Lands	0	0	0
National Forest System Lands	1	2	2
Total	1	2	2
Trunk Pipelines			
National Forest System Lands	6	29	
Total (total length in miles)	6	29	0
Compressor Stations			
BLM Lands	0	0	0
National Forest System Lands	7	21	21
Total	7	21	21
Total Horsepower	42,500	NA[4]	NA
Total Disturbance	NA	788	487

Notes:
1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2 NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance

Sources: Bell 2001, FS and BLM 2003.

Table 2-2 Additional Compression Required for Alternative 1

Legal Description	Jurisdiction	Surface Disturbance (Acres)	Horsepower
Eastern Project Area Compression			
Section 3, T33NU, R5W (Outside the Project Area)	Private	3	5,000
Section 31U, T34NU, R6W	NFS	3	3,000
Section 36U, T34NU, R5W	NFS	3	620
Section 9U, T34N, R5W (3 compressor stations)	NFS	3	1,860
Section 5, T34N, R6W	NFS	3	4,000
Section 32U, T34NU, R6W	NFS	3	18,000
Section 8, T34N, R5W	NFS	3	620
Section 7, T34N, R5W	NFS	3	620
Western Project Area Compression			
Section 36, T35N, R9W[1]	State	0	1,500
Section 2, T34N, R9W	Private	3	240
Section 31, T35N, R6W	Private	3	3,000
Section 36, T34N, R9W	State	3	4,000
Total Number of Compressor Stations	12	33	42,500

Note:
1. These compressors would be installed at existing compressor stations. Thus, no new surface disturbance would occur.

Source: Brown 2001, 2002

The overall life of the project, including construction, production, and reclamation, would be approximately 40 years. Well construction would begin during 2006 and would continue for 5 years. The productive life of each well is expected to be about 25 to 30 years. Production from the wells drilled at the end of the 5-year drilling period would conclude by 2041. Final reclamation of each well would take place during the 2 to 3 years immediately after the end of its productive life. Consequently, the project would be completed by approximately 2045.

Electricity may be used for several aspects of the project. If it is available, the companies may use electricity during well development and to initiate and maintain production. They also may use electric-powered compressors in lieu of gas-fired compressors where electricity is available.

2.3.2 Alternative 2

Alternative 2 is based on the assumption that the demand and price for natural gas will significantly increase in the future, triggering development of CBM beyond that proposed under Alternative 1. As such, Alternative 2 assumes well densities of four per section throughout most of the entire Project Area. Alternative 2 differs from Alternative 1 in the number of wells that would be drilled in the Project Area. Figure 2–3 shows the distribution of drilling windows and wells projected to be developed under this alternative.

The federal action that is the subject of federal decision-making under Alternative 2 would be to allow the drilling of and subsequent production from 324 wells on 301 well pads on federal oil and gas leases in the Project Area.

Alternative 2 requires an estimated 162 miles of collocated access roads and gathering lines, one disposal well, 10 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 2 are presented in Table 2-3.

Table 2-3 Summary of Wells and Ancillary Facilities on Federal Mineral Estate under Alternative 2

Facility	Number	Direct Ground Disturbance[1] Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	22	NA[2]	NA
Private Surface/Federal Minerals	30	NA	NA
National Forest System(fed min)	272	NA	NA
Total	324	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	22	31	29
Private Surface/Federal Minerals	30	42	23
National Forest System (fed min)	249	357	264
Total	301	430	316
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	9	45	28
Private Surface/Federal Minerals	8	40	25
National Forest System Lands	145	700	438
Total	162	785	491
Pipelines (total length in miles)[3]			
BLM Lands	0	0	0
National Forest System Lands	4	23	0
Total	4	23	0
Produced Water Disposal Wells			
BLM Lands	0	0	0
National Forest System Lands	1	2	2
Total	1	2	2
Trunk Pipelines			
National Forest System Lands	6	29	0
Total (total length in miles)	6	29	0
Compressor Stations			
BLM Lands	0	0	0
National Forest System Lands	10	24	24
Total	10	24	24
Total Horsepower	47,500	NA	NA
Total Disturbance	NA	1,293	833

Notes:

1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2 NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance

Sources: Bell 2001, FS and BLM 2003.

The no-surface occupancy stipulations attached to lease numbers COC64932, COC64933, COC64934, COC64935, and COC64936 would be waived and surface occupancy of the leases assumed.

Alternative 2 requires the compression proposed for Alternative 1 (Table 2-2) plus three additional compressor stations at locations identified on Table 2-4. These stations would provide an additional 5,000 horsepower, resulting in a total of 47,500 horsepower for the alternative.

Table 2-4 Additional Compression Required for Alternative 2

Legal Description	Jurisdiction	Surface Disturbance (acres)	Horsepower
Section 28U T34N R6	NFS	3.0	1,000
Section 8U T34N R6W	NFS	3.0	2,000
Section 20U T34N R6W	NFS	3.0	2,000
Compression in proposed action		30.0	42,500
Total		39.0	47,500

Note:
Source: Brown 2001, 2002

2.3.3 Alternative 5 — No Action

NEPA procedural regulations (40 CFR 1502.14) require that federal agencies evaluate in detail a "No Action" alternative that provides a baseline for comparing and measuring the effects of a proposed action and other "action" alternatives. Under the "No Action" alternative, the BLM and FS would not approve the proposed CBM operations on federal leases in the Project Area (Table 2-5 and Figure 2–4).

Drilling would continue on private and state leases, and BLM and FS would grant access across federal lands where other reasonable routes are not available to reach proposed well sites on state and fee lands. Up to 15 wells in the eastern project area would be developed on split estate lands (national forest surface/private minerals), requiring construction of 17 miles of associated access road and pipeline on National Forest surface.

The Department of Interior's and Department of Agriculture's authority to implement a "No Action" alternative that precludes oil and gas development on federal leases is, however, limited. An oil and gas lease grants the lessee the "right and the privilege to drill for, mine, extract, remove, and dispose of all of the oil and gas deposits" in the leased lands, "subject to the terms and conditions incorporated in the lease" (43 CFR 3103.1-2).

Table 2-5 Summary of New Wells and Ancillary Facilities required for Alternative 5 — No Action

		Direct Ground Disturbance[1]	
Facility	Number	Short term (acres)	Long term (acres)
CBM Wells			
BLM Lands	0	NA	NA
National Forest System Lands	0	NA	NA
Total	0	NA	NA
CBM Well Pads			
BLM Lands	0	0	0
National Forest System Lands	0	0	0
Total	0	0	0
Roads/Pipelines (total length in miles)			
BLM Lands	0	0	0
National Forest System Lands	17	82	51
Total	17	82	51
Produced Water Disposal Wells			
BLM Lands	0	0	0
National Forest System Lands	0	0	0
Total	0	0	0
Trunk Pipelines			
BLM Lands	0	0	0
National Forest System Lands	6	29	0
Total (total length in miles)	6	29	0
Compressor Stations			
BLM Lands	0	0	0
National Forest System Lands	1	2	2
Total	1	2	2
Total Disturbance	NA	113	53

Notes:
1. Totals may not match precisely with values obtained by adding unit numbers due to rounding conventions.
2. NA = Not applicable.
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance.
Sources: Bell 2001, FS and BLM 2003.

2.3.4 Alternative 6

Alternative 6 is developed in response to comments regarding the surface impacts of CBM development within the HD Mountains Roadless Area and the impacts that may result from drilling CBM wells within proximity of the Fruitland outcrop. Alternative 6 differs from the Proposed Action (Alternative 1) in the following ways:

- Natural gas resources in the HD Mountains Inventoried Roadless Area are developed from surface locations outside the roadless area.
- Federal mineral estate within the 1.5-mile buffer zone for the Fruitland Formation outcrop is not developed.

Approximately ten well locations could be developed as horizontal wells that drain portions of the HD Mountains Roadless Area if the technology proves to be technically and economically feasible. Approximately ½ the leased gas resource

in the Roadless Area would be accessible from horizontal/directional drilling locations (Figure 2–5).

The federal action that is the subject of federal decision-making under Alternative 6 would be to allow the drilling of and subsequent production from 81 wells on 78 well pads on federal oil and gas leases in the Project Area.

Alternative 6 would require an estimated 47 miles of collocated access roads and gathering lines, one disposal well, 5 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 6 are presented in Table 2-6.

Lease numbers COC–64935 and COC–64936 are maintained as no-surface-occupancy leases. The no-surface occupancy stipulations attached to lease numbers COC–64932, COC–64933, and COC–64934 would be waived and surface occupancy assumed.

2.3.5 Alternative 7 — FS/BLM Preferred Alternative

Alternative 7 is developed in response to comments and is the BLM/FS preferred alternative. Alternative 7 differs from the Proposed Action (Alternative 1) in the following ways:

- Three areas of National Forest where access roads overlay areas with high potential for landslides and mass wasting, are not included in the Project Area in Alternative 7: the lower and upper Ignacio Creek (Zone 1), the area south of the Piedra Stock Driveway rock bridge (Zone 2), and the proposed wells accessed to the south by FS Road 743 (Zone 3) (Figure 2–6). The three zones are not part of this alternative, and decisions for federal actions will be considered when the companies submit site-specific proposals, supported by engineered designs, for those three areas. From the standpoint of describing the environmental impacts of Alternative 7 the three areas are treated as undeveloped.
- Portions of lease numbers COC–64935 and COC–64936, approximately 1,500 acres, are maintained as no-surface-occupancy leases. The no-surface occupancy stipulations attached to lease numbers COC–64932, COC–64933 and COC–64934 are waived and surface occupancy is assumed.
- CBM development within the 1½-mile buffer zone for the Fruitland Formation outcrop in the Fosset Gulch Federal Unit proceeds in a stepwise fashion. Approximately 14 wells mostly on private mineral estate underlying federal surface in T.33N, R.5 W., Sections 9U, 10U, 15U, 16U, 22U, and 23U, would be drilled first. This clustered development would be monitored according to current state requirements for well performance, well interference, water production, and effects to domestic water wells, springs seeps, and the Fruitland outcrop (Section 3.3.10). If monitoring data from these wells indicate identifiable and measurable undesirable effects from production on other production wells, nearby water wells, springs, seeps, and the outcrop, then subsequent wells may

be conditioned to prevent or minimize additional or exacerbated effects. This stepwise approach to the development of the near outcrop zone (¾ miles to 1½ miles) in the eastern Project Area would allow the orderly collection of important production data that would aid in future APD approvals.

Table 2-6 Summary of Wells and Ancillary Facilities on Federal Mineral Estate under Alternative 6

Facility	Number	Direct Ground Disturbance[1] Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	11	NA[2]	NA
Private Surface/Federal Minerals	14	NA	NA
National Forest System(fed min)	55	NA	NA
Total	80	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	11	16	11
Private Surface/Federal Minerals	14	20	14
National Forest System(fed min)	53	112	93
Total	78	148	118
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	3	13	8
Private Surface/Federal Minerals	5	23	13
National Forest System(fed min)	39	188	117
Total	47	224	138
Pipelines (total length in miles)[3]			
BLM Lands	0	0	0
National Forest System Lands	0	0	0
Total	0	0	0
Produced Water Disposal Wells			
BLM Lands	0	0	0
National Forest System Lands	1	2	2
Total	1	2	2
Trunk Pipelines			
National Forest System Lands	6	29	0
Total (total length in miles)	6	29	0
Compressor Stations			
BLM Lands	0	0	0
National Forest System Lands	5	12	12
Total	5	12	12
Total Horsepower	34,000	NA[4]	NA
Total Disturbance	NA	415	270

Notes:
1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2. NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance.

Sources: Bell 2001, FS and BLM 2003.

The federal action that is the subject of federal decision-making under Alternative 7 would be to allow drilling of and subsequent production from 138 wells on federal oil and gas leases in the Project Area.

Alternative 7 requires an estimated 72 miles of collocated access roads and gathering lines, one disposal well, 5 compressor units, and approximately 6 miles of gas trunk line on federal leases within the Project Area. Trunk lines transport gas from the compressors to the transmission pipelines. Ancillary facilities on federal mineral estate by jurisdiction and the amount of direct surface disturbance for Alternative 7 are presented in Table 2-7.

Table 2-7 Summary of Wells and Ancillary Facilities on Federal Mineral Estate under Alternative 7 — Preferred Alternative

		Direct Ground Disturbance[1]	
Facility	Number	Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	12	NA[2]	NA
Private Surface/Federal Minerals	15	NA	NA
National Forest System(fed min)	111	NA	NA
Total	138	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	12	17	12
Private Surface/Federal Minerals	15	21	15
National Forest System(fed min)	100	144	120
Total	127	182	147
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	3	14	9
Private Surface/Federal Minerals	5	23	12
National Forest System(fed min)	64	310	193
Total	72	347	214
Pipelines (total length in miles)[3]			
BLM Lands	0	0	0
National Forest System Lands	4	19	0
Total	4	19	0
Produced Water Disposal Wells			
BLM Lands	0	0	0
National Forest System Lands	1	2	2
Total	1	2	2
Trunk Pipelines			
National Forest System Lands	6	29	0
Undetermined Location	11	53	0
Total (total length in miles)	17	82	0
Compressor Stations			
BLM Lands	0	0	0
National Forest System Lands	5	18	18
Total	5	18	18
Total Horsepower	34,000	NA[4]	NA
Total Disturbance	NA	650	381

Notes:
1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2. NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance.

Sources: Bell 2001, FS and BLM 2003.

2.4 Alternatives Considered but Eliminated from Detailed Study

Several alternatives were considered but eliminated from detailed study. These alternatives are described below, and the reasons they were excluded from detailed analysis are described.

Alternative Considered:	**Moratorium on development on all lands.**
Reasons Considered:	This alternative was considered in response to scoping comments. No further drilling or development of oil or gas wells would occur anywhere within the Project Area.
Reasons Dropped:	This alternative was eliminated from detailed consideration because a moratorium would be inconsistent with the federal lease rights granted and contrary to 43 CFR 3101.1–2. Development of fee and state leases would continue regardless of BLM and FS decisions.
Alternative Considered:	**Analyze 80-acre CBM well density**.
Reasons Considered:	The well density of one well per 80 acres may allow optimum drainage and recovery of CBM gas.
Reasons Dropped:	The BLM spacing order dated May 3, 2000, and COGCC Order 112–156, effective July 11, 2000, limit the spacing of CBM wells in the Fruitland Formation to two per 320 acres in La Plata County and to one per 320 acres in Archuleta County. This alternative was eliminated from detailed consideration because it has not been proposed nor approved by either BLM or COGCC within the Project Area. Additionally, the environmental consequences of such an alternative would be similar to, but somewhat less than Alternative 2, a range of environmental consequences already analyzed by this EIS.
Alternative Considered:	**Alternatives 1A and 1B – analyzed in the DEIS**
Reasons Considered:	Alternatives 1A and 1B were both developed and analyzed in detail in the DEIS to examine how CBM gas development could proceed if short- and long-reach horizontal drilling were feasible and utilized to the maximum extent. The two alternatives' purpose was to examine a way in which surface impacts could be reduced while still draining the same federal lease area as proposed by the companies (Alternative 1).

Reasons Dropped: In practical terms, the drilling and development technologies depicted by the two alternatives can be applied to any of the alternatives considered in detail if their technical and economic feasibility is established. We have chosen not to bring Alternatives 1A and 1B into the FEIS, but consider features of the alternatives that were analyzed in the DEIS as elements that may be adopted in the ROD and in subsequent decision making that would apply to individual wells or development zones in the HD Mountains. Facets of these two alternatives are portrayed in Alternative 6, which has been developed for the FEIS.

Alternative Considered: **Alternatives 3 and 4 – analyzed in draft EIS**

Reasons Considered: Alternative 3 involved reducing the number of wells in the HD Mountains Roadless Area and Alternative 4 analyzed CBM development in accordance with the 1992 CBM development plan for the HD Mountains.

Reasons Dropped: These two alternatives are not brought into the FEIS because they duplicate many of the features incorporated in Alternatives 6 and 7, which were developed in response to comments

2.5 Well Field Development Activities Common to All Alternatives

Appendix E describes well field development activities common to the alternatives. The Appendix describes the procedures and resources used to construct roads, well pads, and ancillary production facilities, and to operate wells and eventually plug, abandon, and reclaim the gas field. This detailed description of procedures and techniques is key to understanding the environmental protection measures used by the companies and required by the regulatory agencies. These requirements have evolved over time through extensive field monitoring and refinement and provide standards and safeguards for CBM gas development.

2.5.1 Environmental Protection Measures

General environmental protection measures for well development and production include the procedures described in the development, production, decommissioning, and reclamation sections of Appendix E. These procedures are subject to the applicable onshore orders, notices, and environmental protection measures listed below. Second, overarching mitigation measures that apply to federal jurisdiction within the Project Area are presented in this EIS. Additional mitigation measures are then developed on a site-specific basis as part of the environmental analysis conducted for individual APD submittals. These site-specific measures consist of

surface protection requirements developed during the NEPA analysis and BLM stipulations that modify the drilling plan (if needed) as conditions of approval for the APD. The APDs on federal jurisdiction would be consistent with the management requirements presented in the record of decision for this EIS.

A complete APD consists of a surface use plan, a drilling plan, evidence of bond coverage, a description of applicable regulations, and BLM orders or notices. The surface use plan describes the access route, water supply, layout of the well site, production facilities, and waste disposal. The surface use plan also describes restoration and revegetation measures associated with the site-specific proposal for well development. The drilling plan includes information that describes the technical aspects of the specific proposal, including measures to protect subsurface resources and accountability for royalties. In addition, BLM Onshore Oil and Gas Orders and Notices to Lessees described below would be applied as standard operating procedures to individual projects and operators.

2.5.1.1 BLM Applicable Onshore Orders and Notices

The following BLM regulations, orders, and notices apply to oil and gas operations in the Project Area:

- 43 CFR Part 3160 – Onshore Oil and Gas Operations
- Onshore Oil and Gas Operating Order No. 1 – Approval of Operations
- Onshore Oil and Gas Operating Order No. 2 – Drilling Operations
- Onshore Oil and Gas Operating Order No. 3 – Site Security
- Onshore Oil and Gas Operating Order No. 4 – Measurement of Oil
- Onshore Oil and Gas Operating Order No. 5 – Measurement of Gas
- Onshore Oil and Gas Operating Order No. 6 – Hydrogen Sulfide Operations
- Onshore Oil and Gas Operating Order No. 7 – Disposal of Produced Water
- Notice to Lessee 3A – Reporting of Undesirable Events
- Notice to Lessee 4A – Royalty or Compensation for Oil and Gas Lost

2.5.2 Hazardous Materials

2.5.2.1 Chemical Use

The companies would use a variety of chemicals, including solvents, lubricants, paints, and additives during gas field development. The chemicals the companies may produce, use, store, transport, or dispose of during the project are identified on Table 2-8.

Table 2-8 Hazardous Materials Used or Potentially Used by the Companies

Material	Primary Use	Project Phase: Construction	Production	Abandonment
Ammonia	Oil coolant/ compression		X	
Gasoline	Vehicle fuel	X	X	X
Diesel fuel	Vehicle and equipment fuel	X	X	X
Motor oil	Vehicle lubricant	X	X	X
Greases/lubricants	Vehicle or equipment lubricant	X	X	X
Solvents	Equipment cleaning/degreasing	X	X	
Heat transfer fluids (glycols)	Removal of residual water		X	
Flocculants	Filtration control	X		
Lost circulation material	Controlling drilling circulation	X		
Sodium hydroxide	PH control of drilling mud	X	X	
Buffers	PH control during completion	X	X	
Acids	Well stimulation	X	X	
Surfactants	Gas processing (CO_2 removal)		X	
Paint	Equipment painting	X	X	
Cement additives (accelerators and weight modification)	Cement casings and reworking within the well bore and abandonment	X	X	X
Sand	Fracture propant in hydro fracturing	X	X	
Inert gas	Well stimulation	X	X	
Welding and cutting material	Equipment welding and cutting	X	X	X
Fertilizers	Reclamation	X	X	X
Herbicides	Reclamation weed control	X	X	X

Potentially hazardous substances used to develop or operate wells are stored in limited quantities on well sites. The companies are required to follow the Material Safety Data Sheets when using such substances. Wastes generated by these processes typically include produced water, oilfield production fluids (including drilling muds and used fracturing fluids), crude oil and condensate, and contaminated soils. The U.S. Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) regulate these materials.

Disposal of some quantities of crude oil and condensate typically involves sale of these wastes to a waste oil recycler. Soils contaminated with relatively low concentrations of hydrocarbons (petroleum products) are generally disposed of in an approved landfill that accepts non-hazardous wastes. They may also be treated on site through land farming or aeration if permitted by the local regulatory agencies.

Any operations that involve storage of large volumes of oil at CBM facilities are required by the provisions of 40 CFR 112 to prepare Spill Prevention Control and

Countermeasures (SPCC) plans that specify containment requirements and drainage control measures to prevent any spills from reaching waters of the U.S.

2.5.2.2 Waste Sources and Controls

A variety of wastes are produced during the drilling and production phases. These wastes include drilling solids, steel drums, waste oils, spent oil filters, washer parts, cleaning solvents, spent water filters, water, triethylene glycol, and spent glycol filters. All wastes described in this section are recycled or disposed of in accordance with applicable laws and regulations.

Solids or cuttings are produced during the drilling stage. The cuttings are bits of rock produced as the drill bit bores though the target interval. The solids would be buried in the drilling pit after fluids have evaporated or have been pumped into trucks and transported to approved disposal facilities. These liquid wastes may include water, treatment fluids, and fracturing fluids.

Empty steel and plastic drums that contained materials such as caustic soda, citric acid, lubricating oil, methanol, and drilling additives require disposal or recycling. Empty metal or plastic drums are returned to the supplier.

Waste lubricating oil generated at the compressor stations and production sites are disposed of by the contractor. Some fluids are generated at compressor stations when pipelines are cleaned. These fluids are stored in a 50-gallon sump tank. The contents of the tank are removed by a contractor using a vacuum truck and are transported to a permitted disposal or recycling site.

Each compressor station creates an additional waste oil product through the bypass system. This waste is a combination of about 90 percent water and 10 percent hydrocarbons. The compressor bypass fluids also are piped to the sump tanks, as discussed above.

Solid wastes generated at the compressor stations include spent gas filters and cleaning rags that are handled as general trash and are sent to the regional landfill. Spent oil filters from the compressor lubrication systems are removed and disposed of at an approved facility.

Several waste streams are generated from the triethylene glycol dehydration line at the compressor stations. The dehydration units remove water from the gas stream by contacting the gas with triethylene glycol. Applying heat regenerates the glycol. The water is boiled off and released as steam.

Sanitary wastes are collected in portable toilets located on well pads during drilling and completion. The contractor pumps these toilets regularly and removes them when drilling is finished the well are completed.

Construction materials and trash are transported to approved disposal areas. General trash would be collected in covered containers and periodically transported to approved disposal areas.

The existing federal statutes enacted to minimize risks to public health associated with hazardous materials and wastes include the Resource Conservation and Re-

covery Act 1976 (RCRA), the Superfund Amendments and Reauthorization Act of 1986 (SARA), which amended the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA or "Superfund"), and the federal Clean Air, Clean Water, and Safe Drinking Water Acts (CAA, CWA, and SDWA). Federal and state regulations also apply.

Under CERCLA, listed hazardous substances are the elements, chemical compounds, and hazardous wastes that appear in Table 302.4, 40 CFR Part 302, Designation, Reportable Quantities, and Notification. The reportable quantity for each listed hazardous substance is also provided in Table 302.4. Spills or releases of reportable quantities that occur beyond the boundary of the facility must be reported to EPA and local agencies as required by Section 101(14) of CERCLA.

2.5.3 Safety and Emergency Response

This section describes the methods that the companies use to ensure safe operation of the natural gas wells during development and production. It also describes how the companies would respond to emergencies.

2.5.3.1 Geologic Hazards

Abnormally high pressure (blowouts) can occur during drilling operations. However, more than 1,000 CBM wells have been drilled in the NSJB with no recorded blowouts. All wells drilled are required to install Blowout Prevention Equipment (BOPE) to control any abnormal pressures that might be encountered. Blowouts are considered highly unlikely because of the BOPE, the shallow depths of the wells, the normal formation pressures, and experience in the Fruitland Formation.

2.5.3.2 Fires and Explosions

There is potential for leaks or ruptures from gas pipelines. Most ruptures are caused when heavy equipment accidentally strikes the pipeline when it is operating in close proximity. Ruptures can result in an explosion and fire if a spark or open flame were to ignite the escaping gas. Pipelines are designed and materials are selected in accordance with applicable standards to minimize the potential for a leak or rupture. Frequent signing is also installed along the pipelines to reduce the risk of accidental ruptures caused by excavating equipment. Additionally, the companies monitor flow in the pipeline either by remote sensors or by daily inspections of the flow meters. Monitoring therefore reduces the probability of ruptures by promoting prompt detection of leaks.

Well fires are rare, but may occur under certain conditions. The probability of a blowout is low for the reasons listed in the previous sections. However, as part of the emergency plan the companies would contract one of the several businesses that specialize in controlling well fires if a fire were to occur.

2.5.3.3 Public Safety

The companies take measures to protect the public from hazards at well facilities. For example, all compressor stations would be fenced. According to OSHA regulations, a guardrail at pumping units would prevent people and large animals

from injury by moving parts. In addition, warning signs would be posted around all facilities.

2.5.3.4 Employee Safety

The companies develop plans that cover potential emergencies including fires, employee injuries, and releases of chemicals and hydrogen sulfide (H_2S). The plans include telephone numbers for medical and emergency services and emergency contacts. The plans are posted at all local company offices and field facilities. All employees and subcontractors are knowledgeable of the emergency plan, and refresher courses are presented annually.

In addition, the companies generally do not allow on-duty employees and contractors to bring firearms into the area. They also orient employees and contractors to techniques that protect local wildlife.

2.6 Consistency with Law, Regulation

The Roadless Area Conservation Rule (RACR), promulgated January 12, 2001, would have established prohibitions on road construction and reconstruction in inventoried roadless areas on NFS lands with certain exceptions for roads associated with development of leasable minerals. However, on July 14, 2003, the United States District Court for the District of Wyoming issued an order that permanently enjoined RACR. Development activities on two leases in the HD Mountains Inventoried Roadless Area would have been subject to road construction/reconstruction prohibitions if RACR were in effect. The FS provided consent to BLM to issue the leases at a time when the status of RACR was in question. Consequently, the leases were issued with No Surface Occupany (NSO) stipulations subject to waiver, exception, or modification to be addressed in the environmental analysis and record of decision for this project.

More recently, the FS has issued a final revised RACR that establishes that baseline management requirements for roadless areas are those that exist in the currently approved LRMPs. For the San Juan National Forest, the guiding management direction for the HD Mountains Roadless Area is the direction established in the current SJNF LRMP (FS 1983). The HD Mountains Roadless Area is managed according to a number of prescriptions that establishes the Area's management emphasis. The two leases in question are within a management area (MA) where mineral development and road building are allowed.

The leaseholder has proposed to develop one of the two leases in a manner that would require surface occupancy and a waiver of the NSO stipulation. This plan is embedded in Alternative 1 — The Proposed Action. Road construction and surface occupancy of portions of the two roadless area leases is also included in Alternatives 2, 6, and 7. Alternative 5 maintains the NSO requirements currently placed on the leases and would allow development of portions of the leases from outside the boundary of the inventoried roadless area.

The alternatives comply with all other applicable laws and regulations.

2.7 Summary CBM Development Activities, by Alternative, on all Jurisdictions within the Project Area

The environmental consequences of CBM development on non-federal jurisdictions within the Project Area are analyzed in detail for cumulative effects. Consequently, in addition to satisfying federal requirements for environmental analysis, this EIS also provides the local counties an impact analysis that aids in local, non-federal decision-making. The following narrative and tables describe the total number of wells, miles of road and pipeline, and ancillary facilities that would be constructed on each jurisdiction as a result of the proposed action, maximum development and no action alternatives. There are a number of drilling windows within the Project Area that are split on more than one jurisdiction (for example, a portion of a 27-acre drilling window may be BLM and another portion of the same window may be private). On these windows, the jurisdiction that would be developed would be influenced by BLM decisions to allow or not allow drilling on federal mineral estate. Alternative 5, for example, would prohibit drilling of federal mineral estate, resulting in more development on private mineral estate as reflected in Table 2-11.

Table 2-9 presents, by jurisdiction, the companies' proposal for the entire Project Area. Table 2-10, presents the level of new development that may occur as a result of maximum development of all open drilling windows within the Project Area, on all jurisdictions. And Table 2-11 presents the level of development that would occur within the Project Area, on private and state mineral estate as a result of no development of federal minerals (the No Action Alternative).

Table 2-9 Summary of New Wells and Ancillary Facilities on all Jurisdictions within the Project Area — The Proposed Action

Facility	Number	Direct Ground Disturbance[1] Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	**12**	**NA [2]**	**NA**
Private Surface/Federal Minerals	**15**	**NA**	**NA**
National Forest System(fed min)	**158**	**NA**	**NA**
State Lands	7	NA	NA
Private Mineral Estate	92	NA	NA
Total	284	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	**12**	**17**	**12**
Private Surface/Federal Minerals	**15**	**21**	**15**
National Forest System(fed min)	**135**	**197**	**144**
State Lands	7	10	7
Private Lands	92	129	92
Total	261	374	270
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	**4**	**19**	**9**
Private Surface/Federal Minerals	**5**	**23**	**12**
National Forest System(fed min)	**88**	**436**	**272**
State Lands	1	7	4
Private Lands	18	87	60
Total	116	572	357
Pipelines (total length in miles)[3]			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**4**	**23**	**0**
State Lands	0	0	0
Private Lands	<1	1	0
Total	5	24	0
Produced Water Disposal Wells			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**1**	**2**	**2**
State Lands	0	0	0
Private Lands	0	0	0
Outside the Project Area	2	4	3
Undetermined Location	0	0	0
Total	3	6	5
Trunk Pipelines			
Undetermined Location	17	82	0
Total (total length in miles)	17	82	0
Compressors			
Stations			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**7**	**21**	**21**
State Lands	2	6	6
Private Lands[4]	2	3	3
Outside Project Area	1	3	3
Undetermined Locations	0	0	0
Total	12	33	33
Total Horsepower	42,500	NA[4]	NA
Total Disturbance	NA	1,091	665

Notes:

1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2. NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance.

Sources: Bell 2001, FS and BLM 2003.

Table 2-10 Summary of New Wells and Ancillary Facilities Required on all Jurisdictions -- Maximum Development

Facility	Number	Direct Ground Disturbance[1] Short term (acres)	Long term (acres)
CBM Wells			
BLM Surface/Federal Minerals	**22**	**NA[2]**	**NA**
Private Surface/Federal Minerals	**30**	**NA**	**NA**
National Forest System(fed min)	**272**	**NA**	**NA**
State Lands	15	NA	NA
Private Lands	175	NA	NA
Total	514	NA	NA
CBM Well Pads			
BLM Surface/Federal Minerals	**22**	**31**	**29**
Private Surface/Federal Minerals	**30**	**42**	**23**
National Forest System(fed min)	**249**	**357**	**264**
State Lands	15	21	15
Private Lands	175	246	171
Total	491	697	502
Roads/Pipelines (total length in miles)			
BLM Surface/Federal Minerals	**9**	**45**	**28**
Private Surface/Federal Minerals	**8**	**40**	**25**
National Forest System(fed min)	**145**	**700**	**438**
State Lands	3	15	10
Private Lands	48	233	147
Total	202	1,033	648
Pipelines (total length in miles)[3]			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**4**	**23**	**0**
State Lands	0	0	0
Private Lands	< 1	1	0
Total	5	24	0
Produced Water Disposal Wells			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**1**	**2**	**2**
State Lands	0	0	0
Private Lands	0	0	0
Outside the Project Area	2	4	3
Undetermined Location	0	0	0
Total	3	6	5
Trunk Pipelines			
Undetermined Location	17	82	0
Total (total length in miles)	17	82	0
Compressors			
Stations			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**10**	**24**	**24**
State Lands	2	6	6
Private Lands[4]	2	3	3
Outside the Project Area	1	3	3
Undetermined Locations	0	0	0
Total	15	36	36
Total Horsepower	47,500	NA.	NA
Total Disturbance	NA	1,878	1,197

Notes:

1. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.
2 NA = Not applicable.
3. Pipelines not associated with roads
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance

Sources: Bell 2001, FS and BLM 2003.

Table 2-11 Summary of New Wells and Ancillary Facilities Required on all Jurisdictions -- No Action Alternative

		Direct Ground Disturbance[1]	
Facility	Number	Short term (acres)	Long term (acres)
CBM Wells			
BLM Lands	**0**	**NA [2]**	**NA**
National Forest System Lands	**0**	**NA**	**NA**
State Lands	7	NA	NA
Private Lands	110	NA	NA
Total	117	NA	NA
CBM Well Pads			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**0**	**0**	**0**
State Lands	7	10	7
Private Lands	110	154	110
Total	117	164	119
Roads/Pipelines (total length in miles)			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**17**	**82**	**51**
State Lands	1	5	3
Private Lands	25	121	76
Total	43	208	130
Produced Water Disposal Wells			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**0**	**0**	**0**
State Lands	0	0	0
Private Lands	0	0	0
Outside the Project Area	0	0	0
Undetermined Location	0	0	0
Total	0	0	0
Trunk Pipelines			
Undetermined Location	10	49	0
Total (total length in miles)	10	49	0
Compressors			
Stations			
BLM Lands	**0**	**0**	**0**
National Forest System Lands	**1**	**2**	**2**
State Lands	2	6	6
Private Lands[4]	2	3	3
Outside the Project Area	1	3	3
Undetermined Locations	0	12	12
Total	6	26	26
Total Horsepower	13,740	NA	NA
Total Disturbance	NA	447	275

Notes:
1. Totals may not match precisely with values obtained by adding unit numbers due to rounding conventions.
2. NA = Not applicable.
3. These locations are on NFS surface overlying private minerals.
4. Two proposed stations are located on existing stations and are therefore not included in this disturbance.

Sources: Bell 2001, FS and BLM 2003.

2.8 Summary of Alternatives and Environmental Consequences

Table 2-12 summarizes the alternatives in terms of their physical impact and facilities required for each alternative. Also included is a summary of the cumulative level of development that would occur within the Project Area as a result development across all jurisdictions in each alternative. Table 2-13 is a comparative summary of the environmental consequences that would be realized by implementing each of the five alternatives.

Table 2-12 Comparative Summary of Alternatives Considered in Detail

		Alternative				
Parameter	Existing	1	2	5	6	7
CBM Development on Federal Mineral Estate within the Project Area						
CBM Wells (number)	310	185	324	0	80	138
CBM Well Pads (number)	310	162	301	0	78	127
Short-Term Disturbance (acres)	691	788	1,293	113[1]	415	650
Long-term Disturbance (acres)	552	487	833	53	270	381
Roads/Pipelines (total length in miles)	58	91	162	17	47	72
Gathering Pipelines (total length in miles)	0	4	4	0	0	4
Produced Water Disposal Wells (number)	6	1	1	0	1	1
Compressor Stations (number)[2]	6	7	10	1	5	5
Trunk Pipelines (total length in miles)	6	6	6	6	6	6
CBM development on all Jurisdictions within the Project Area						
CBM Wells (number)	310	284	514	117	178	237
CBM Well Pads (number)	310	261	491	117	176	226
Short-Term Disturbance (acres)	691	1,091	1,878	447	697	807
Long-term Disturbance (acres)	552	665	1,197	275	428	545
Roads/Pipelines (total length in miles)	58	116	202	43	66	92
Gathering Pipelines (total length in miles)	0	5	5	0	1	4
Produced Water Disposal Wells (number)	6	3	3	0	3	3
Compressor Stations (number)[1]	6	12	15	6	9	10
Trunk Pipelines (total length in miles)	6	17	17	10	17	17

Note:
1. Land disturbance due to roads constructed on National Forest to access split estate lands (National Forest Surface/private minerals).
2. Number of compressor stations resulting in new surface disturbance.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Methane Seeps					
Ground water impacts.	The 3M model predicts that gas seepage has occurred and will continue to occur at the current seeps in the western Project Area. The model also predicts increases in the areal extent of methane seeps, regardless of the additional development represented by the alternatives. As a consequence, the number of shallow domestic wells, seeps, and springs that may be affected by methane seepage may also increase. According to the state water engineer's database, 40 domestic water wells are situated on the outcrop of the Fruitland Formation, mostly in La Plata County. Any number of these wells may be affected with increased concentrations of methane as a result of CBM development. Drought and the gas desorbing effects of the domestic wells themselves, may also contribute to groundwater impacts, both in terms of quantity and quality of water produced from domestic wells. Domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop are and would continue to be monitored for change in quantity and quality of water.	Impacts would be similar to Alternative 1.	As with the other alternatives, up to 40 shallow domestic wells may see an increase in concentrations of methane. .In the eastern Project Area there would be a lower probability of methane seepage affecting domestic water wells due to limited overall CBM development. A total of 14 private wells and 2 state wells would be drilled within proximity of the Fruitland Formation outcrop. No wells would be drilled on federal mineral estate.	Western project area impacts would be the same as Alternative 1, up to 40 shallow domestic wells may see an increase in concentrations of methane. The impacts of Alternative 6 would be similar to Alternative 5 in the eastern Project Area. CBM development within proximity of the Fruitland Formation outcrop would be limited to 14 private wells and 2 state wells. This limited development (compared to alternatives 1, 2, and 7) would lower the potential for methane seepage impacts to domestic water wells.. Domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop are and would continue to be monitored for change in quantity and quality of water.	The impacts of Alternative 7 would be similar to Alternative 1 in both the eastern and western Project Area. Up to 40 shallow domestic wells may see an increase in concentrations of methane Alternative 7 would first involve development of a cluster of approximately 14 wells in the Fosset Gulch Federal Unit in the eastern Project Area. Development would be monitored according to federal and state requirements for well performance, well interference, water production, and effects to domestic water wells, springs and seeps, and the Fruitland outcrop (Section 3.3.10). The production and monitoring data derived from wells would then be used to condition subsequent development of federal leases in the Fosset Gulch Unit. This stepwise approach to the development of the near outcrop zone (3/4 miles to 1 ½ miles) in the eastern Project Area would allow the orderly collection of production and monitoring data that would aid federal APD approvals. Domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop are and would continue to be monitored for change in quantity and quality of water.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Surface water impacts.	Surface water affected by CBM development is limited to small springs emanating from the Fruitland Formation and the Pictured Cliffs Sandstone. Larger bodies of surface water (Texas Creek; the Animas, Pine, and Florida Rivers) are already subject to methane seepage from naturally occurring methane seeps and from the current CBM well field. These seeps are not predicted to increase in overall rate. Therefore, methane seepage from additional CBM development would have no further impact these surface water bodies. Squaw Creek, at Yellowjacket Pass, may experience increased methane seepage, and other unnamed springs along the eastern portion of the outcrop may additionally be affected by methane seepage, as may the Piedra River as CBM development proceeds in the eastern Project Area. Springs emanating from the Fruitland Formation have been identified through pedestrian surveys of the outcrop area. These springs would continue to be monitored as CBM development proceeds. As a minimum, presence of methane, flow rate and water chemistry would be measured on a periodic basis. Mitigation could include altering operation of wells to limit water production, or other measures as appropriate.	Alternative 2 may accelerate the effects of methane seepage in surface water bodies along the outcrop of the Fruitland Formation. Increased methane seepage to surface water would negligibly affect surface water chemistry.	Methane seeps would likely be lower in surface water bodies in the eastern portion of the Project Area. Squaw Creek, the Piedra River, and other small ground water seeps and springs would likely see little or no impact because the intensity of development in the near-outcrop area would be reduced. There would be no development of federal mineral estate. Impacts to surface water bodies in the central and western Project Area would be similar to other alternatives because the existing well field would continue operating, and infill CBM development would continue on private mineral estate.	The western Project Area methane seepage impacts to surface water bodies as a result of Alternative 6 would be the same as predicted for Alternative 1. Development of the eastern Project Area would differ measurable from Alternative 1 because there would be no development of federal leases within the 1 ½ mile near outcrop zone of the Fruitland Formation. Therefore, the potential for methane seeps, and particularly seeps impacting springs, seeps and other surface water bodies would be low. The monitoring described in Section 3.3.10 is designed to identify springs and to monitor change over time. COGCC could require alteration of private and state well operation or other measures to mitigate outcrop impacts if they were to occur.	The impacts of Alternative 7 to surface water bodies would be same as Alternative 1 in the western Project Areas and similar to Alterative 1 in the eastern Project Area. The difference between Alternatives 1 and 7 is the way in which Alternative 7 would proceed with development in the Fosset Gulch Unit within the band of proposed wells that are ¾ mile to 1 ½ miles from the Fruitland outcrop. The stepwise approach of developing and monitoring a cluster of approximately 14 wells would facilitate the collection of monitoring information that would aid in federal APD approvals and management of potential surface water impacts. Springs emanating from the Fruitland Formation have been identified through pedestrian surveys of the outcrop area. These springs would continue to be monitored as CBM development proceeds. As a minimum, presence of methane, flow rate and water chemistry would be measured on a periodic basis. Mitigation could include altering operation of wells to limit water production, or other measures as appropriate.
Health and safety concerns.	Sixty residential-type structures along the Fruitland Outcrop may be affected by methane seepage, thus exposing the residents to safety risks. Homes would be continuously monitored for presence of methane gas.	Potential impacts would be similar to Alternative 1throughout the Project Area.	Potential impacts would be similar to Alternative 1 in the western Project Area. CBM development on private and state mineral estate in the eastern Project Area may also affect residences on the outcrop of the Fruitland Formation. The potential for this impact to occur would be reduced, however, with the lower intensity of development in this eastern Project Area.	Potential impacts would be similar to Alternative 1 in the western Project Area Similar to Alternative 1, the residences in the eastern Project Area along Fossett Gulch Road may be affected by methane seepage, thus exposing the residents to safety risks. However, by not developing wells on federal mineral estate in the 1 ½ mile near outcrop zone, Alternative 6 would present a lower risk than Alternative 1 of impacting residences proximal to the Fosset Gulch unit.	The sixty residential-type structures along the Fruitland Outcrop may be affected by methane seepage, thus exposing the residents to safety risks. However, stepwise development of wells in the zone ¾ mile to 1 ½ miles of the outcrop would facilitate monitoring of CBM development prior to proceeding with further APD approvals on federal mineral estate. Homes would be monitored for presence of methane gas.

Table 2-13 Summary of Effects, by Alternative

ISSUE	Alternative 1	Alternative 2	Alternative 5	Alternative 6	Alternative 7
Vegetation impacts.	The proposed action may expand the acreage of plant die-off caused by methane seeps along the Fruitland Formation outcrop. Existing CBM development and Alternative 1 could expand the area of vegetation die off by an estimated 510 acres, in addition to the 130 acres affected by the existing CBM well field The 3M model likewise predicts increased methane seepage in the eastern Project Area as a result of new CBM development. This methane seepage could result in vegetation die-off. However, well development near the Fruitland outcrop in the eastern Project Area may have a lower potential of triggering methane seepage than the western Project Area due to the characteristics of the area's coals. The monitoring requirements implemented in 2005 are designed to detect vegetation change at the outcrop and to monitor for increases in methane seepage, and the mitigation measures are designed to manage impacts if they were to occur.	Vegetation impacts associated with Alternative 2 should be similar to those described under Alternative 1. As with Alternative 1, increased vegetation die-off may occur along the outcrop. As many as 510 additional acres of vegetation may be affected by CBM development within the Project area. The impacts would be the result of existing development in the western Project Area and new development in the eastern Project Area. .	Vegetation die-off would be similar to Alternative 1 in the western Project Area due to existing development. Vegetation die-off could expand beyond the 130 acres that the existing CBM well field is predicted to affect. With predicted increased areal extent of methane seepage between the Animas River and Beaver Creek, the area of vegetation die-off could also increase in the western Project Area. Some additional acreage may be affected in the eastern Project Area because of development of private mineral estate. However, CBM development is limited to 14 private and two state wells and because of the hydrological and coal characteristics, the potential for vegetation die-off in the eastern Project Area would be low.	The western Project Area impacts of Alternative 6 would be the same as predicted for Alternative 1. Development of the Project Area's east side would differ from Alternative 1 because there would be no development of federal leases within the 1 ½ mile near outcrop zone of the Fruitland Formation. Therefore, the potential for vegetation die off along the Fruitland outcrop in the eastern Project Area would be less than Alternative 1 due to limited development of private mineral estate within proximity of the Fruitland outcrop.	The western Project Area impacts of Alternative 7 would be the same as predicted for Alternative 1. The eastern Project Area impacts would be similar to Alternative 1. The 3M model predicts increased methane seepage in the eastern Project Area as a result of new CBM development that could ultimately lead to vegetation die-off. The monitoring implemented in 2005 is designed to detect vegetation change at the outcrop and to monitor for increases in methane seepage, and the mitigation measures are designed to manage impacts if they were to occur.
Wildlife impacts	The Proposed Action may expand the acreage of habitat loss due to increased vegetation die-off. The duration of this effect is unknown, because some of the methane seep areas begin vigorously and subside as production continues. Furthermore, some methane seep areas appear to persist. Some plant life would be reestablished within several years in areas where the seeps subside. The new plant life could lead to a change in habitat, as grasses and shrubs eventually replace dead trees. In contrast, the persistent seep areas do not allow for revegetation. Moreover, according to the results of the 3M model, these seeps may persist for several centuries. The areas affected by methane seeps should gradually be reduced, as CBM wells are plugged and abandoned and the Fruitland aquifer begins to recharge.	Impacts would be similar to Alternative 1.	The No Action alternative would have the same habitat effects as Alternative 1 in the western Project Area due to existing development and continued development of private mineral estate. No CBM development would occur in the 1 ½ mile Fruitland outcrop zone, thus reducing potential methane seepage impacts. There may be some minor impacts from methane seepage induced by CBM development on private mineral estate in the eastern Project Area.	The impacts to wildlife habitat would be the same as anticipated for Alternative 1 in the Project Area's west side. In the eastern Project Area, the potential for habitat loss due to loss of vegetation would be less than Alternative 1 because there would be no development of federal mineral estate within 1 ½ miles of the Fruitland outcrop.	The impacts to wildlife habitat would be the same as anticipated for Alternative 1 in the Project Area's west side. In the eastern Project Area, the potential for habitat loss due to loss of vegetation die off would be similar to Alternative 1. Because there would be development of federal, private and state mineral estate between ¾ mile and 1 ½ miles of the Fruitland outcrop, there would be potential for vegetation/habitat impacts along the Fruitland Formation outcrop

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Soil impacts	Because of vegetation die-off, additional bare soils may be exposed on the outcrop of the Fruitland Formation. These soils would be susceptible to accelerated erosion.	Impacts would be similar to Alternative 1.	Alternative 5 would potentially affect additional acres of soils as a result of current and projected CBM development of private and state leases in the western Project Area. Vegetation die-off and consequent effects to soils in the eastern Project Area would probably be minimal due to very limited CBM development on private and state mineral estate.	The impacts of this alternative would be the same as Alternative 1 in the western Project Area. Additional area of bare soils may be exposed on the outcrop of the Fruitland Formation, primarily in the western Project Area. These soils would be susceptible to accelerated erosion. Eastern Project Area impacts to vegetation and soils would be less than Alternative 1, because there would be no development of federal leases within 1 ½ miles of the Fruitland formation.	The impacts of Alternative 7 would similar to Alternative 1.
Geology and Minerals					
Effects of CBM development on landforms and physical landscapes.	CBM development would alter naturally occurring outcrops and deposits whenever surface exposures are excavated. The stratigraphy, structure, and contacts between geologic units would not be affected, however.	Wells and associated facilities would result in long-term surface disturbance of about 1,250 federal acres, highest among the alternatives. The impacts associated with landform disturbance would be very minor.	Wells and associated facilities would result in long-term surface disturbance of about 150 federal acres, lowest among the alternatives. The impacts associated with landform disturbance would be very minor.	Wells and associated facilities would result in long-term surface disturbance of about 425 federal acres. The impacts associated with landform disturbance are very minor.	Wells and associated facilities would result in long-term surface disturbance of about 650 federal acres. The impacts associated with landform disturbance are very minor.
Paleontological effects.	Little of the Project Area has been inventoried for the presence of paleontological resources. Consequently, the number of paleontological sites that may be affected cannot be accurately estimated. Paleontological resources contained in near-surface horizons of soil and natural processes or human activity has likely already impacted surficial deposits. Surface use and shallow excavations likely would have little or no effect on paleontological resources that occur just below the surface. All facilities constructed on federal mineral ownership would be considered federal undertakings, and thus would be subject to federal guidelines and regulations that protect paleontological resources.	Impacts to paleontological resources would be potentially greater than the effects described under Alternative 1. Because more than 200 additional well pads (nearly half on private and state lands) would be developed under this alternative, it is likely that more impacts could occur during surface disturbing activities.	Alternative 5 would involve far fewer federal undertakings that would be subject to federal guidelines and regulations that protect paleontological resources than under the other alternatives. Therefore, potential paleontological impacts would be the lowest among alternatives on NF land and the same as Alternative 1 on private, State, and BLM jurisdiction.	. Because 85 fewer well pads would be developed under this alternative, it is likely that there would be less potential for paleontological resource damage during surface-disturbing activities.	Impacts of Alternative 7 to paleontological resources likely would be similar to the effects described under Alternative 1. Because 35 fewer well pads would I be developed under Alternative 7, it is likely that there would be less potential for paleontological resource damage during surface-disturbing activities.
Effect on coal or other mineral development opportunities.	CBM development is not expected to impact coal mining operations because no active coalmines occur in the Project Area or are planned in the future. Nor would future opportunities to mine coal be impacted after CBM extraction is completed or terminated. CBM development could interfere with the potential recovery of sand, gravel, and aggregate. CBM development could remove an estimated 1 to 3 acres of land from mineable mineral reserves for each well that would be located in an area that could be surface mined. Mining likely could not occur near wellheads, injection wells, pipelines, or utilities without damaging oil or gas production facilities.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1. Drainage of federal CBM resources would increase because only non-federal CBM wells would be drilled.	Impacts to coal and other mineral resources would be similar to the effects described under Alternative 1.	Impacts to coal and other mineral resources would be similar to the effects described under Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
ISSUE	1	2	5	6	7
Impacts of produced water injection on subsurface geologic stability.	No excessive buildup of pressure within rocks or fracturing of rocks is anticipated to result from produced water injection. Therefore, no underground injection triggered earthquakes would be expected. Underground injection would be conducted in accordance with federal and state regulatory requirements. Injection wells would be authorized only where the injection zone is sufficiently porous and permeable that fluids could enter the rock formation without causing an excessive buildup of pressure or fracturing of rocks.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Impacts of Fruitland formation ground water withdrawal on subsurface geologic stability.	Removal of water from the Fruitland coal seam would not cause noticeable ground subsidence or aquifer compression in the Project Area under any of the alternatives. Water would be extracted from the Fruitland formation, which is a consolidated rock unit and, therefore, would not be susceptible to noticeable subsidence.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Impacts of hydraulic fracturing or cavitation on subsurface geologic stability.	Hydraulic fracturing and cavitation would not compromise the integrity of the coal and surrounding formations. Therefore, it is not expected that the stability of the subsurface geology would be affected.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Potential for increased CBM development to exacerbate existing coal fires or increase the likelihood of new coal fires.	Partial removal of water from the coal seam near the coal outcrop depressurizes the coal seam and could leave it in a condition where oxygen could replace water in the coal seam and increase the risk of spontaneous combustion. Therefore, it is anticipated that the potential for coal fires may increase but should be mitigated by proper operation of the wells.	The risk of coal fires would increase with additional wells close to the Fruitland outcrop.	The risk of coal fires would decrease with fewer wells close to the outcrop.	The risk of coal fires would decrease with fewer wells close to the outcrop.	The risk of coal fires would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Ground water					
Potential for CBM dewatering to deplete ground water in shallow aquifers.	The Fruitland formation is a confined hydrostraigraphic unit throughout most of the Project Area. Dewatering the coal beds would not affect the shallow aquifers within the interior of the Basin that supply almost all the domestic wells, municipal wells, and livestock wells within the Project Area. Increased CBM development would, however, continue to draw down the water levels in wells located along the outcrops of the Fruitland and Pictured Cliffs formations. Some number of 40 well owners may be affected by lower water tables in the outcrop area. Increased development of CBM will continue to draw down the water levels in wells located along the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone. It will also continue to lower water levels in the two wells known to draw water from the Pictured Cliffs within the interior of the basin. Domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop are and would continue to be monitored for change in quantity and quality of water. Draw down of the water table along the outcrop may affect groundwater seeps and springs. Effects in the western Project Area are not expected to increase under Alternative 1. Effects in the eastern portion of the Project Area may include draw down of the water table along the outcrop, with possible effects on springs and seeps. Springs and seeps would be monitored for change in water quality and quantity	Alternative 2 would accelerate the drawdowns in domestic wells along the outcrop of the Fruitland Formation and Pictured Cliffs Sandstone. It is expected that some number of the 40 known private domestic wells would be affected by drawdowns associated with CBM development.	Alternative 5 would result in much lower impacts to the water table on the outcrop of the Fruitland Formation in the eastern portion of the Project Area because there would be no development of federal mineral estate. The Alternative would result in the same impacts described for Alternative 1 in the Project Area's west side	Alternative 6 impacts in the western Project Area would be essentially the same to those described in Alternative 1 because of the same level of CBM development would occur on all jurisdictions. As many as 40 domestic water-well owners may be affected by lower water tables in the outcrop area. Alternative 6 impacts in the eastern Project Area would be as described for Alternative 5 – the No Action Alternative. As with Alternative 5, CBM development would be limited to 14 wells developed on private mineral estate/federal surface and two wells on State lands. There would be no federal development within 1 ½ miles of the Fruitland outcrop. The 16 CBM wells may have minor impact on Fruitland groundwater regimes at the outcrop. As described above, COGCC monitoring provisions placed on private wells in the far eastside Project Area require comprehensive water well monitoring. COGCC required mitigation would be to limit the amount of water produced from CBM wells if necessary. This limitation would reduce the impacts to groundwater at the Fruitland Formation outcrop.	Alternative 7 impacts to domestic water wells would be the same those described for Alternative 1 in the eastern and western Project Area. Domestic water wells that tap the shallow aquifer close to the Fruitland Formation outcrop are and would continue to be monitored for change in quantity and quality of water.
Effect of produced water injection on basin hydrology.	Although the deep hydrology of the basin would be affected by injection of produced water, these effects are not expected to manifest themselves in shallow aquifers or usable groundwater supplies. Impacts would not be evident as long as injection wells are constructed and operated according to current regulations and best engineering practices.	Impacts would be similar to Alternative 1. The primary difference is that increases in pressure in deeper formations will extend over a broader area because of the increased number of injection wells.	There would be a slightly lower quantity of produced water injected into deeper formations when compared to Alternative 1.	Effects would be similar to Alternative 1. However, because there would be fewer production wells in Alterative 6, the volume of produced water would be less. Therefore, the pressure changes in the deep formations would be less and would have a smaller area of influence.	Impacts of Alternative 7 would be similar to those described in Alternative 1
Effect of dewatering and injection on groundwater.	Injected produced water would increase pressure in the deep formations and alter groundwater chemistry. Mixing of ground water between aquifers would not occur from dewatering the Fruitland formation.	Impacts would be similar to Alternative 1, except that increases in pressure in the deeper formations would extend over a broader area because of an increase in the number of injection wells.	Lower amounts of produced water would be injected into deeper formations, reducing the amount of mixing and the degree of pressure buildup in these deeper formations.	Effects would be similar to Alternative 1. Alternative 6 would decrease the amount of groundwater mixing in deeper formations by lessening the overall volume of injected water.	Impacts would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Surface Water					
Potential for surface water degradation because of petroleum product and produced water spills.	Potential short-term surface water quality impacts could result from accidental spills of fuel, lubricants, and fluids during construction of well pads, associated facilities, roads, and pipelines in water influence zones (WIZ). Long-term impacts over the life of the project could occur from leaks or breaks in the pipelines that run from the wells to the disposal facilities. Relocating facilities outside of the WIZ, where possible, would reduce the potential for impacts, as would Spill Prevention Control and Countermeasures (SPCC) plans using Best Management Practices (BMPs). The probability of spills is low.	Impacts of Alternative 2 would be similar to Alternative 1, but somewhat greater because of the higher level of development resulting from this alternative.	Impacts would be similar to Alternative 1 on non-federal lands and very low on Federal lands due to absence of development.	The potential for spills of petroleum or CBM produced waters would be slightly lower than Alternative 1 in the western side of the Project Area and much lower than Alternative 1 on federal lands in the eastern side of the Project Area. Fewer wells, and pipelines overall would be constructed as compared to Alternative 1.	The potential for spills of petroleum or CBM produced waters would be the same as Alternative 1 in the western side of the Project Area and potentially lower than Alternative 1 on federal lands in the eastern side of the Project Area.
Potential for access roads and pipelines to degrade water quality.	CBM development of federal mineral estate would impact 68 acres in the water influence zone (WIZ) in the short term and 42 acres in the WIZ in the long term. This disturbance would lead to potential annual soil loss (potential sedimentation) of 660 tons per year in the WIZ in the short term and 420 tons in the long term. Well pads and roads would be relocated or realigned to avoid disturbance in the WIZ where possible. Roads would be located to avoid unstable slopes. Facility construction would avoid streams, wetlands, and riparian areas where possible.	CBM development of federal mineral estate would impact 112 acres in the WIZ in the short term and 69 acres in the WIZ in the long term. Disturbance would lead to potential annual soil loss (potential sedimentation) of 1,190 tons in the short term and 770 tons in the long term. Potential impacts to water quality would be greater than Alternative 1.	CBM development of federal mineral estate would impact 25acres in the WIZ in the short term and 16 acres in the WIZ in the long term. Disturbance would lead to potential annual soil loss (potential sedimentation) of 250 tons in the short term and 160 tons in the long term. Potential impacts to water quality would be less than under Alternative 1.	CBM development of federal mineral estate would impact 35 acres in the WIZ in the short term and 23 acres in the WIZ in the long term. Disturbance would lead to potential annual soil loss (potential sedimentation) of 360 tons in the short term and 230 tons in the long term. Potential impacts to water quality would be less than under Alternative 1.	CBM development of federal mineral estate would impact 50 acres in the WIZ in the short term and 33 acres in the WIZ in the long term. Disturbance would lead to potential annual soil loss (potential sedimentation) of 460 tons in the short term and 320 tons in the long term. Potential impacts to water quality would be less than under Alternative 1.
Impact of change in surface water flow on riparian areas and wetlands.	Surface water depletions are predicted to be less than one percent of base flow in the Animas, Pine, and Florida Rivers. Localized impacts to wetland and riparian areas could occur along perennial and ephemeral drainages crossed by access roads.	Impacts would be similar to Alternative 1.	Depletion in the Piedra River would be less than other alternatives because there would be no CBM development of federal mineral estate. There would continue to be development of 14 private wells and two state wells that may intercept groundwater that normally discharges to the Piedra River. The depletion impact of Alternative 5 to the Piedra River cannot be quantified however, although it should be less than Alternatives 1, 2 and 7.	Impacts would be similar to Alternative 1. Impacts to the Piedra River as a result of Alternative 6 would be less than Alternative 1 due to limited CBM development of federal mineral estate in the eastern Project Area.	Impacts would be similar to Alternative 1.
Interaction between the Fruitland Aquifer and surface water systems after gas production ceases.	Rate of recharge of the Fruitland Formation aquifer primarily depends on meteoric recharge at the outcrop and not on leakage from streams that are hydraulically connected with the Fruitland Aquifer. Depletions less than one percent would occur over the life of the Project and interactions between surface flows and the Fruitland Aquifer would return to pre-CBM levels once the aquifer is recharged.	Impacts would be similar to Alternative 1.	Impacts would similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Consumption of domestic and irrigation water for well development.	Overall, over the life of the project, 96 acre-feet of water would be required for drilling of federal wells. Water would be purchased from municipal sources or private entities. Individual landowners would negotiate terms for the purchase of water. Therefore, 0.03 percent of irrigation use would shift to industrial use.	A total of 156 acre-feet would be needed to drill federal wells and would be purchased from municipal sources or private entities. Individual landowners would negotiate terms for the purchase of water. Therefore, 0.03 percent of irrigation use would shift to industrial use.	There would be no federal wells drilled under Alternative 5 and thus no consumptive use of water.	A total of 46 acre-feet would be needed to drill federal wells and would be purchased from municipal sources or private entities. Individual landowners would negotiate terms for the purchase of water. Therefore, 0.03 percent of irrigation use would shift to industrial use.	Overall, 81 acre-feet would be needed to drill federal wells and would be purchased from municipal sources or private entities. Individual landowners would negotiate terms for the purchase of water. Therefore, 0.03 percent of irrigation use would shift to industrial use.
Effect of water depletions on existing surface water rights.	Existing water users would be affected by annual 140-acre-feet depletions in the Florida, Pine, and Animas Rivers and 15 to 60 acre-feet in the Piedra River.	Impacts would be similar to Alternative 1.	Impacts similar to Alternative 1, except in the eastern Project Area CBM development would not intercept groundwater that normally discharges to the Piedra.	The environmental effects would be similar to Alternative 1 and greater than Alternative 5.	The environmental effects would be similar to Alternative 1 and greater than Alternative 5.
Beneficial use of produced water.	Produced water would be marginal to poor quality. Marginal quality water may require treatment (reverse osmosis or ion exchange) to meet required standards for livestock and wildlife. Suitability of surface discharge would depend on specific water quality.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Soils					
Soil erosion.	Construction of federal wells would impact 95 acres with high potential for water erosion and 20 acres of soils with high potential for wind erosion, with some overlap of soils exhibiting both hazards. Soil loss due to federal construction activities would total 7,700 ton/year during construction and 5,100 tons/year during the operational phase. Erosion impacts would be reduced by measures that include slope breakers, silt fencing, drainage dips, stockpile seeding, and graveling roads.	Construction of federal wells would impact 220 acres of soils with high potential for water erosion and 35 acres of soils with high potential for wind erosion in the short term (with some overlap on soils that exhibit both characteristics). Soil loss due to federal construction activities would be 12,600 ton/year during construction and 8,300 tons/year during the operational phase. Impacts would be greater than all other alternatives.	CBM development on federal surface (split estate lands) would impact 15 acres of soils with a high potential for water erosion and 5 acres with a high potential for wind erosion. These soils are also concentrated in the western part of the Project Area. The level of soil loss due to federal construction activities (split estate construction) would be 1,200 ton/year during construction and 770 tons/year during the operational phase. Impacts would be the least of all alternatives.	CBM development of federal mineral estate would impact 35 acres of soils with a high potential for water erosion and 15 acres with a high potential for wind erosion. These soils are also concentrated in the western part of the Project Area. The level of soil loss due to federal construction activities would be 3,800 ton/year during construction and 2,700 tons/year during the operational phase.	CBM development of federal mineral estate would impact 45 acres of soils with a high potential for water erosion and 15 acres with a high potential for wind erosion. These soils are also concentrated in the western part of the Project Area. The level of soil loss due to federal construction activities would be 5,700 ton/year during construction and 3,900 tons/year during the operational phase.
Potential for contaminant spills to affect soils.	Probability of spills is low at CBM sites. Spills would be contained, disposed of, or treated on site. Therefore, the probability of permanent soil contamination is very low.	Potential for contaminant spills is higher than Alternative 1 due to the higher level of development in Alternative 2.	Potential for contaminant spills is lower than Alternative 1 due to lower level of CBM development in Alternative 5.	Potential for contaminant spills is higher than Alternative 1 due to the higher level of CBM development in Alternative 6.	Potential for contaminant spills is lower than Alternative 1 due to the lower level of CBM development in Alternative 7.
Impact to areas with poor revegetation potential and prime farmlands.	CBM development of federal mineral estate would impact 270 acres of soils with poor potential for revegetation and no acres of prime farmland.	CBM development of federal mineral estate would impact 470 acres of soils with poor potential for revegetation and 3 acres of prime farmland. Impacts would be greater than Alternative 1.	CBM development of federal mineral estate would impact 68 acres on soils with poor potential for revegetation. These impacts would occur on split estate lands (federal surface/private minerals). Impacts would be the least of all alternatives.	CBM development of federal mineral estate would impact 135 acres of soils with poor potential for revegetation and no acres of prime farmland.	CBM development of federal mineral estate would impact 190 acres of soils with poor potential for revegetation and no acres of prime farmland.
Vegetation					
Impact of CBM development on vegetation in the Project Area, including wetlands, riparian areas.	Total vegetation converted to well pads, roads, pipelines and compressors on federal mineral estate would equal 755 acres; riparian disturbance would equal 3 acres.	Total vegetation converted to well pads, roads, pipelines and compressors on federal mineral estate would equal 1,205 acres; riparian disturbance would equal 3 acres.	Total vegetation converted to well pads, roads, pipelines and compressors on federal surface (private minerals) would equal 90 acres; riparian disturbance would equal 3 acres.	Total vegetation converted to well pads, roads, pipelines and compressors on federal mineral estate would equal 350 acres; riparian disturbance would equal 3 acres.	Total vegetation converted to well pads, roads, pipelines and compressors would equal 530 acres; riparian disturbance would equal 3 acres. If some level of construction is subsequently approved in the three zones where development is deferred, then potential for impacting vegetation could approach Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Impact on habitat structural stages.	Forested areas reclaimed after CBM development would differ substantially from undisturbed areas in terms of habitat structural stages (HSS). Reclaimed areas may not serve functions now served by undisturbed vegetation communities, particularly in the first few years, when species composition, shrub and tree cover, and other environmental factors would likely be different. Reclaimed areas would initially be in early seral HSSs, but would eventually develop into late seral HSSs in the absence of other disturbances.	Impacts would be similar to Alternative 1.	Impacts would similar to Alternative 1. But the extent of impact would be less than Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Noxious weed control.	Operators would submit a noxious weed control plan during the APD process. Measures to reduce noxious weed infestations include pressure-washing vehicles before entering public lands; treating all infestations using methods approved by the Authorizing Officer and treating all infestations for 5 years after detection.	Impacts would be greater than Alternative 1 because of more facilities and land disturbed.	Impacts least of all alternatives because of fewest facilities and lands disturbed.	Impacts would be less than Alternative 1 because of fewer facilities would be constructed and land disturbed.	Impacts would be less than Alternative 1 because of fewer facilities would be constructed and land disturbed.
Effect on old-growth ponderosa pine and other old growth forest types.	CBM development would impact 36 acres (5 percent of old-growth ponderosa pine in Project Area). Impacts would occur on National Forest. Because the old growth occurs in fairly continuous stands, avoidance may be difficult.	CBM development would affect 36 acres (5 percent of old-growth ponderosa pine in Project Area). Impacts would be the highest of all the alternatives.	CBM development would not affect any old-growth ponderosa pine in Project Area. Impacts would be the least of all alternatives.	CBM development would impact 3 acres (>1 percent of old-growth ponderosa pine in Project Area). Because the old growth occurs in fairly continuous stands, avoidance may be difficult.	CBM development would impact 13 acres (2 percent of old-growth ponderosa pine in Project Area). Because the old growth occurs in fairly continuous stands, avoidance may be difficult.
Impact on ecological processes including fire and insects and disease.	Frequency of human-caused wildfires may increase because of CBM development and road access. At the same time, the road network would increase ability to suppress fires and reduce spread in previously limited access areas. Cut trees and limbs during construction may increase *Ips* beetle infestation.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Impact of additional CBM development on federal and state listed threatened, endangered, proposed, candidate, and sensitive plant species and their habitats.	Areas of proposed facilities would be surveyed for T, E, and sensitive plant species, and avoidance utilized to mitigate impacts. Therefore, implementation of any of the alternatives may adversely impact individuals, but is not likely to result in a loss of viability on the planning area. This determination is based on the low likelihood that the species occurs within the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and implementation of avoidance measures if new occurrences are discovered.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Wildlife					
Potential for wildlife harassment, roadkill, hunting pressure, and wildlife displacement.	In response to increased human activity, equipment operation, vehicular traffic, and noise associated with all phases of each alternative, wildlife may avoid CBM development and production activities and displace to other locations. This avoidance would result in the under-utilization of otherwise suitable habitats. Therefore, the effectiveness of these habitats in supporting wildlife would be diminished and wildlife distribution patterns would be altered. The degree of habitat avoidance would vary between species and among individuals of any particular species. CBM well access roads would provide increased access to public land in the Project Area as a whole; potentially leading to both increased legal-hunting pressure and poaching. Private landowners would continue to control hunting on, split-estate and private lands. Most project roads would be designed for slower speeds and not likely to cause any substantial increase in vehicle collisions. Most collisions occur on county roads and highways, where speeds are greater and where the vast majority of traffic is not CBM-related. Nevertheless, an increase in CBM traffic would occur on these roads, as well, and a minimal increase in vehicle collisions may occur.	Wildlife displacement would be greater than that anticipated for Alterative 1. Hunting pressure would be similar to Alternative 1 and the risk of vehicle collisions would be slightly higher that Alternative 1 due to higher CBM industry traffic volume associated with the higher CBM development levels of Alternative 2.	Overall, wildlife impacts would be similar to Alternative 1 in the west side of the Project Area where CBM development is primarily on private and state land. Displacement, hunting, and risk of vehicle collisions in the eastern Project Area would be lower than Alternative 1 because there would be no development of federal mineral estate.	Wildlife displacement would be less than that anticipated for Alternative 1. Hunting pressure would be similar to Alternative 1 and the risk of vehicle collisions would be slightly lower than Alternative 1 due to higher CBM industry traffic volume.	Wildlife displacement would be slightly lower than that anticipated for Alternative 1 due to the lower level of development of federal wells in the HD Mountains under Alternative 7. Hunting pressure would be similar to Alternative 1 and the risk of vehicle collisions would be slightly lower than Alternative 1 due to lower CBM industry traffic volume.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Impact of additional CBM development on wildlife habitat.	Direct loss of wildlife habitat would occur under each alternative during the construction phase of the project, because of road, well pad, and other facility construction. Habitat loss would reduce available forage and habitat components in the affected area. Habitats next to those directly disturbed may be degraded by changes in vegetation, including the invasion of noxious weeds. Alternative 1 would impact no more than 2-percent of habitat for each MIS.	No more than 3-percent of habitat for each MIS would be impacted by Alternative 2.	No more than 1-percent of habitat for each MIS would be impacted by Alternative 5.	No more than 2-percent of habitat for each MIS would be impacted by Alternative 6.	No more than 2-percent of habitat for each MIS would be impacted by Alternative 7.
Fisheries impacts.	The abundance and distribution of brown trout within the Project Area are determined by stream flow and related water temperature dynamics. For the perennial streams in the Project Area, water temperatures increase, and brown trout abundance decreases, in a downstream progression. Coal bed methane development would reduce flows in perennial streams in and downstream of the Project Area. The dewatering of coal seams would reduce surface water flows by reducing groundwater discharge to streams, and by increasing surface water interception and infiltration When combined, the depletions of surface flows resulting from the pumping of groundwater, and from the use of surface flows for drilling, deplete about 216 acre-feet per year. A variety of historic and ongoing water uses have had, and will continue to have, significant impacts on the above streams. The predicted changes in flow resulting from CBM development would be insignificant, by comparison. However, stream flows and water temperatures are primary biological limiting factors for trout populations occupying Project Area streams. As such, any water depletion may contribute to the overall cumulative effects of basin wide water uses on aquatic resources and fish populations, in and downstream from the Project Area.	Impacts would be similar to Alternative 1	There would be no incremental impact to fisheries in the eastern Project Area because development would not occur on federal mineral estate. Fisheries impacts within the western Project Area would be as described in Alternative 1.	Impacts would be similar to Alternative 1	Impacts would be similar to Alternative 1
Effect of additional CBM development on federal and state listed threatened, endangered, proposed, candidate, and sensitive animal species and their habitats.	The Project "may affect – but is not likely to adversely affect federal listed threatened, endangered, proposed, candidate, and sensitive animal species and their habitats. The exception is fish species where the effects determination is: may affect, and is likely to adversely affect, the Colorado pikeminnow and razorback sucker.	Impacts would be similar to Alternative 1	There would be no terrestrial species impacts as a result of federal CBM development because there would be no development of federal mineral estate. Endangered fish impacts would be the same as Alternative 1. Alternative 5 may affect, and is likely to adversely affect, the Colorado pikeminnow and razorback sucker.	Impacts would be similar to Alternative 1	Impacts would be similar to Alternative 1

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Cultural Resources					
Cultural resource impacts.	Alternative 1 would disturb 2.8 times as much new area and 8.3 times as much federal (BLM and FS) surface as Alternative 5 – the No Action alternative. Measures can be implemented to avoid the impacts for the majority of the properties under federal jurisdiction. Twenty-four percent of the proposed areas of surface disturbance will be federal actions subject to Section 106 review. Some actions on private surface may also be subject to Section 106 review. Alternative 1 will affect 57 known cultural resources. Twenty-two of these cultural resources are eligible or unevaluated. Forty-three of the cultural resources are on federal surface and 17 of those on Forest land are eligible or unevaluated sites. The eligible or unevaluated sites that may be affected on Forest land include two at known pad locations and 15 along proposed road or pipeline corridors. The largest number of eligible sites that may be affected are large prehistoric sites. The unevaluated sites would be evaluated and plans would be developed to avoid or mitigate impacts to all eligible sites.	Alternative 2 would affect 4.8 times as much total new surface and 13.3 times as much federal surface as Alternative 5. Measures can be implemented to avoid effects for the majority of historic properties under federal jurisdiction. Sixty-nine percent of the proposed areas of surface disturbance will be federal actions subject to Section 106 review. Some actions on private surface may also be subject to Section 106 review. Alternative 2 would affect 111 known cultural resource sites or isolated finds. Thirty-seven of the sites are recommended eligible or unevaluated. Eighty-seven of the cultural resources are on federal surface and 29 of those are recommended eligible or unevaluated for the National Register. The unevaluated sites would be evaluated and plans would be developed to avoid or mitigate impacts to all eligible sites.	Alternative 5 would affect 31 known cultural resources. More than half of the known sites that would be affected by Alternative 5 are on private lands and would not be subject to Section 106 review. Thirteen of the sites that may be impacted occur on federal surface, and eight of those are eligible or unevaluated. The effects projected for Alternative 5, the No Action Alternative, are common to all alternatives. Where the effects to historic properties occur on private land, the private surface owner would have the final decision on treatment of historic properties.	Alternative 6 would affect 1.7 times as much total new surface and 3.8 times as much federal surface as Alternative 5. Measures can be implemented to avoid effects for the majority of historic properties under federal jurisdiction. Fifty-six percent of the proposed areas of surface disturbance will be federal actions subject to Section 106 review. Some actions on private surface may also be subject to Section 106 review. Alternative 6 would affect 52 known cultural resource sites or isolated finds. Seventeen of the sites are recommended eligible or unevaluated. Thirty-eight of the cultural resources are on federal surface and fourteen of those are recommended eligible or unevaluated for the National Register. The unevaluated sites will be evaluated and plans would be developed to avoid or mitigate impacts to eligible sites.	Alternative 7 would affect 2.8 times as much total new surface and 6.0 times as much federal surface as Alternative 5. Measures can be implemented to avoid effects for the majority of historic properties under federal jurisdiction. Sixty-six percent of the proposed areas of surface disturbance will be federal actions subject to Section 106 review. Some actions on private surface may also be subject to Section 106 review. Alternative 7 would affect 55 known cultural resource sites or isolated finds. Twenty-two of the sites are recommended eligible or unevaluated. Forty-one of the cultural resources are on federal surface and seventeen of those are recommended eligible or unevaluated for the National Register. The unevaluated sites would be evaluated and plans would be developed to avoid or mitigate impacts to all eligible sites.
Effect on traditional cultural properties.	See Above.	See Above.	See Above.	To be determined	To be determined
Land Use					
Agricultural and residential land use impacts.	CBM development would impact 124 acres of agricultural lands and 91 acres of residential lands. None of these impacts would occur as a result of CBM development on federal mineral estate.	CBM development would impact 221 acres of agricultural lands and 164 acres of residential lands. None of these impacts would occur as a result of CBM development on federal mineral estate.	CBM development would impact 121 acres of agricultural lands and 102 acres of residential lands. None of these impacts would occur as a result of CBM development on federal mineral estate.	CBM development would impact 124 acres of agricultural lands and 92 acres of residential lands. None of these impacts would occur as a result of CBM development on federal mineral estate.	CBM development would impact 124 acres of agricultural lands and 91 acres of residential lands. None of these impacts would occur as a result of CBM development on federal mineral estate.
Unroaded area impacts.	Fifty-seven well pads and 38 miles of roads would be constructed in the unroaded portion of the HD Mountains. Approximately 44-percent of the unroaded area would be impacted, leaving 15,400 acres unroaded.	Alternative 2 would result in construction of 103 well pads and 61 miles of road in the unroaded portion of the HD Mountains. Alternative 2 would impact 22,800 acres of unroaded area, the largest impact among the alternatives. Three residual pockets of unroaded area would remain, totaling 4,997 acres.	Alternative 5 would not affect the unroaded portion of the Project Area.	Seven well pads and 3 miles of roads would be constructed in the unroaded portion of the HD Mountains. Approximately 9-percent of the unroaded area would be impacted, leaving 25,300 acres unroaded.	Thirty well pads and 13 miles of roads would be constructed in the unroaded portion of the HD Mountains. Approximately 17-percent of the unroaded area would be impacted, leaving 23,000 acres unroaded.
NSO leases within HD Mountain Inventoried Roadless Area.	Nine-wells would be constructed within the lease area COC-64935, currently issued with a no-surface-occupancy stipulation. There are no wells proposed within lease COC-94936 at this time.	Nine-wells would be constructed within the lease area COC-64935, currently issued with a no-surface-occupancy stipulation. Six wells would be developed within lease area COC-64936	There would be no development of lease areas COC-63935 and COC-64936 at this time.	Lease areas COC-64935 or COC-64936 would not be developed under Alternative 6.	Three wells and associated access roads would be developed in lease area COC-64935. There would be no development in lease area COC-64936.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Development of Archuleta Mesa potential research natural area.	Seven wells and one compressor would be constructed within lease COC-64932 (the Archuleta Mesa lease area). A potential 3,600-acre research natural area is just to the east of the lease block is being evaluated as part of the land and resource management plan revision.	Impacts would be the same as Alternative 1.	There would be no development of COC-64932 at this time.	Impacts would be the same as Alternative 1.	Impacts would be the same as Alternative 1.
Recreation					
Impact of additional CBM development on trail system and users.	The recreational setting of the Grandview Ridge and Sauls Creek trails would be impacted by CBM development on private and federal mineral estate. One well would be developed within proximity of the Grandview trail system and 12 wells would be developed within proximity of the Sauls Creek Trail.	Thirteen wells would be constructed within proximity of the Grandview Trail system and 45 facilities would be within proximity of the Sauls Creek Trail. Overall impacts to the recreation settings that encompass the trail systems would be the highest under Alternative 2.	The number of facilities that would be constructed within proximity of the Grandview Trail system would be the same as Alternative 1. However, about half the number of facilities would be constructed within proximity the Sauls Creek Trail. However, impacts would be lower than Alternative 1	Effects to the Grandview and Sauls Creek Trail systems would be the same as Alternative 1.	Effects to the Grandview and Sauls Creek trail systems would be the same as Alternative 1.
Effect on recreational opportunities.	The predominantly natural setting of much of the National Forest portion of the Project Area would be impacted by Alternative 1 CBM development. The western portion of the Project Area has experienced some level of development and landscape alteration and would be further impacted by additional CBM development. There would be 12 additional wells drilled on BLM lands, further altering the landscape character of the BLM recreation setting.	Impacts to the current natural setting would be greater than Alternative 1. Significantly more wells would be developed on all jurisdictions with a corresponding loss of backcountry setting	There would be 14 wells developed on National Forest lands (Split estate) within proximity of the Fosset Gulch road with a corresponding impact to the natural setting of the area. Impacts to recreational settings in the western project area would be the same as Alternative 1 due to CBM development on private, state, and BLM land.	Effects to recreation settings on NFS lands would be much less than Alternative 1 on National Forest in the western Project Area. The effects would be the same in the western Project Area on private, state, and BLM lands.	Impacts to recreation settings on National Forest in the eastern Project Area as a result of CBM development would be less than Alternative 1 due to the lower level of development in the three zones that comprise: Ignacio Creek, the area south of the relay tower, and area south of the Piedra Stock Driveway rock bridge. Effects on recreational settings would be the same on the west side of the Project Area on private, state, and BLM lands.
Effect of new access roads on recreation.	New roads would be constructed into previously inaccessible areas of the National Forest. Many of these roads would be gated and therefore not available for expanded motorized recreation. The backcountry ambiance of much of the National Forest portion of the Project Area would be diminished.	Effects would be similar to but greater than Alternative 1. New roads would be constructed into previously inaccessible areas of the National Forest Many of these roads would be gated and therefore not available for expanded motorized recreation. The backcountry ambiance of much of the National Forest portion of the Project Area would be diminished.	Few additional roads would be constructed within the National Forest portion of the Project Area (only those required to access private mineral estate on split estate lands), retaining its backcountry setting. Lands within the west side of the Project Area would experience the same level of development as Alternative 1, and thus the same diminishment of recreational setting. Motorized access to BLM lands would remain the same as current management.	Fewer new roads would be constructed within the National Forest portion of the Project Area than required under Alternative 1. Thus, the loss of backcountry settings in the eastern portion of the Project Area would be less than under Alternative 1. The effects would be the same for the western of the Project Area	Fewer new roads would be constructed within the National Forest portion of the Project Area than Alternative 1. Thus, the loss of backcountry setting in the eastern portion of the Project Area would be less than under Alternative 1. The effects of CBM development on recreation settings would be the same as Alternative 1 in the western Project Area.
Effect on wildlife-related recreation including wildlife viewing wildlife, hunting, and fishing.	The number of hunters utilizing the federal lands would probably not increase because motorized use of most new roads would be prohibited. New access roads could be traveled on foot or horseback, increasing ease of access to some hunters. The change in recreation setting to a more developed landscape may displace some hunters attracted to backcountry settings. For similar reasons, the number of persons participating in fishing and wildlife viewing would probably not increase.	Effects would be similar to Alternative 1.	No development would occur on National Forest lands in the eastern portion of the Project Area. On NF lands, traditional patterns of recreation use would remain unchanged.	Effects would be similar to but lower than Alternative 1 because there would be less of the National Forest portion of the Project Area developed.	Effects would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Transportation					
Effect of additional CBM development on transportation and roads.	Overall, 118 miles of new access road would be constructed. Of that total, 93 miles of these roads would be constructed on National Forest and BLM lands. Most of the National Forest roads would be gated to public motorized access, thus limiting the amount of traffic utilizing the roads to industry vehicles only. Traffic increases on county roads and U.S. Highway 160, especially during the construction phase, would be small compared to the average daily traffic volumes.	Overall, 151 miles of new access roads would be constructed on National Forest and BLM lands. All of the new roads would be gated and locked to prevent motorized access. Traffic increases on county roads and U.S. Highway 160 especially during the construction phase would be greater than Alternative 1 because of the significantly higher level of development required of Alternative 2.	Overall, 17 miles of new access roads would be constructed on National Forest and BLM lands to access split estate lands (private minerals). Access to the National Forest portion of the Project Area would not change Traffic increases on county roads and U.S. Highway 160 especially during the construction phase would be less than Alternative 1 but still greater that currently experienced.	About 42 miles of new access roads would be constructed on National Forest and BLM lands. A small portion of these roads would be open to seasonal public uses. Effects on the regional road system would be similar to Alternative 1.	About 67 miles of new access roads would be constructed on National Forest and BLM lands. A small portion of these roads would be open to seasonal public uses. Effects of CBM company traffic on traffic congestion and wear and tear of the regional road system would be similar to Alternative 1.
Potential for new roads to promote illegal activities such as poaching, illegal woodcutting, disturbance of cultural sites, and wildlife disturbance.	The 93 miles of new roads constructed on National Forest and BLM lands would be gated to restrict public access. Illegal activities could increase despite closures. Closures would be monitored.	All of the new roads would be gated and closed to the public. However, the expanded road system could contribute to an increase in illegal activities behind closed gates.	A total of 17 miles of new roads would be constructed on National Forest lands to access split estate lands. Therefore, the potential for illegal activities would not increase measurably.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1. Most of the 67 miles of new roads constructed on National Forest and BLM lands would be gated to restrict public access. Illegal activities could increase despite closures. Closures would be monitored.
Impacts on recreation in the HD Roadless Area.	Roads would be constructed in the HD Mountains Roadless Area directly impacting the backcountry recreation setting of a portion of the area. All new roads would be gated to prohibit motorized access. Nevertheless, foot and horseback traffic could increase along with illegal use of the road system by ATV's.	Effects would be similar to Alternative 1.	No roads would be constructed in the HD Mountains Roadless Area. Patterns of recreation use would not change.	There would be no impact to the HD Mountains Roadless Area as a result of Alternative 6.	The land area of the HD Mountains Roadless Area impacted by roads would be less than Alterative 1 because there would be less miles of road and fewer well pads constructed in within the area in Alternative 7. All new roads in the HD Mountains Roadless Area would be gated to prohibit motorized access.
Effect of gas industry traffic on public safety.	The probability of increased traffic accidents would be small because the expected CBM traffic volume would be less than 1 percent of the average daily traffic volume on county roads and U.S. Highway 160. However, there may be an increased potential for incidents at road intersections where traffic turns onto county roads.	Effects to county roads in the eastern Project Area would be less than Alternative 1 because there would be no development of federal mineral estate.	Effects would be similar to Alterative 5 because of the very limited development of federal mineral estate in the eastern Project Area.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1. The probability of increased traffic accidents would be small because the expected CBM traffic volume would be less than 1 percent of the average daily traffic volume on county roads and U.S. Highway 160. However, there may be an increased potential for incidents at road intersections where traffic turns onto county roads.
Effect of industry vehicles on road surfaces and maintenance levels.	A 26-percent increase in heavy trucks on county roads would accelerate road deterioration. However, traffic of this vehicle size would be limited to the short-term construction phase of about 2 weeks for each well drilled. La Plata County requires the operators to maintain county roads to a level determined adequate by the county engineer.	Effects would be similar to Alternative 1.	There would be no increase in CBM induced traffic in the eastern Project Area, and thus no change in county road traffic patterns. The western Project Area would experience increase in heavy truck traffic similar to Alternative 1.	Effects would be similar to Alternative 5.	Effects would be similar to Alternative 1. A 26-percent increase in heavy trucks on county roads would accelerate road deterioration. However, traffic of this vehicle size would be limited to the short-term construction phase of about 2 weeks for each well drilled. La Plata County requires the operators to maintain county roads to a level determined adequate by the county engineer
Visual Resources					
Visual effect of CBM development in relationship to FS' visual management guidelines.	Visual impacts of federal well development would exceed the FS visual objective of Retention in the foreground view (to ½ mile) for 21 acres from residential areas, 24acres from roads, and 30 acres from recreational areas.	Visual impacts of federal well development would exceed the FS visual objective of Retention in the foreground view (to ½ mile) for 23acres from residential area, 25 acres from roads, and 53 acres from recreational areas.	Visual impacts of federal well development would exceed the FS visual objective of Retention in the foreground view (to ½ mile) for 6acres from residential area, 6 acres from roads, and 2 acres from recreational areas.	Visual impacts of federal well development would exceed the FS visual objective of Retention in the foreground view (to ½ mile) for 20 acres from residential area, 22 acres from roads, and 14 acres from recreational areas.	Visual impacts of federal well development would exceed the FS visual objective of Retention in the foreground view (to ½ mile) for 21 acres from residential area, 21acres from roads, and 23 acres from recreational areas.

Table 2-13 Summary of Effects, by Alternative

ISSUE	Alternative 1	Alternative 2	Alternative 5	Alternative 6	Alternative 7
Visual impacts of CBM development when viewed from sensitive viewpoints including highways, roads, and residential areas.	CBM facilities, especially compressor stations and pump jacks, would be noticeable in sensitive viewshed areas. Visual impacts would be greatest where development encroaches on residential areas, along roads, and in open areas not screened by topography or vegetation. Overall, visual intrusion would be moderate to high in localized areas	Visual impacts would be similar to Alternative 1 but significantly greater within the Fruitland outcrop zone and Spring Creek areas of the Project Area: .	There would be no additional visual impact through out most of the HD Mountains, with the exception of Sauls Creek where private land CBM development would incrementally increase visual impacts. Visual impacts would be the same as Alternative 1 throughout the rest of the Project Area, where impacts would be moderate to high in localized situations.	There would be less visual impact through out most of the HD Mountains than under Alternative 1. Visual impacts would be the same as Alternative 1 throughout the west side of the Project Area, where impacts would be moderate to high in localized situations.	Visual impacts would be the same as Alternative 1 throughout the west side of the Project Area, where impacts would be moderate to high in localized situations. Visual impacts of CBM development on National Forest in the eastern Project Area would be slightly lower than Alternative 1 because three zones n the HD Mountains Roadless area would not be developed.
Visual effects of construction and operation of pipelines, power lines, fences, and roads.	Long, linear CBM facilities (roads and pipeline construction) would be more noticeable than short or curved facilities following terrain features. These CBM facilities would be most noticeable at short distances in the western portion of the Project Area because of the population density. However, linear features on elevated terrain in the eastern portion of the Project Area would also be easily seen from all elevations except where topography would screen these features.	Impacts would be slightly greater in the western portion of the Project Area because of more development.	Impacts would be the least of all alternatives because of the least number of linear facilities.	Impacts in the eastern portion of the Project Area would be less than under Alternative 1. However, impacts would be similar in the western portion of the Project Area	Road and pipeline visual effects in the western portion of the Project Area would be similar to Alternative 1. Impacts in the eastern portion of the Project Area would be slightly lower than Alternative 1 because three zones n the HD Mountains Roadless area would not be developed.
Visual effects of flaring,	Typically, a CBM well would be flared for 3 to 5 days. Without topographic or vegetative screening, the flare would be seen at distances to 3 miles and sometime more. A reflection on low clouds would make the effect more noticeable. It is assumed that 1 to 3 wells would be flared at any time. Impacts would be temporary and low.	More wells would be flared than under the other alternatives. Therefore, the visual effects would be more widespread but still temporary and low.	Impacts similar to Alternative 1 throughout the west side of the Project Area. There would be no impact within the National Forest portion of the Project Area, with exception of Sauls Creek where limited additional development would occur on private land.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Visual consequences of nighttime lighting of compressor stations.	Fourteen new compressor stations (10 on National Forest and BLM) would be lighted with downward-directed light that would diminish the night shine from these facilities. However, the stations would be visible at night especially for nearby residents. Impacts would be localized and moderate.	Seventeen new compressor stations would be lighted with downward-directed light that would diminish the night shine from these facilities. However, the stations would be visible at night especially for nearby residents. Impacts would be localized and moderate.	Five new compressor stations would be lighted with downward-directed light that would diminish the night shine from these facilities. Impacts would be localized and moderate.	Nine new compressor stations would be lighted with downward-directed light that would diminish the night shine from these facilities. Impacts would be localized and moderate.	Ten new compressor stations (5 on National Forest and BLM) would be lighted with downward-directed light that would diminish the night shine from these facilities. Impacts would be localized and moderate.

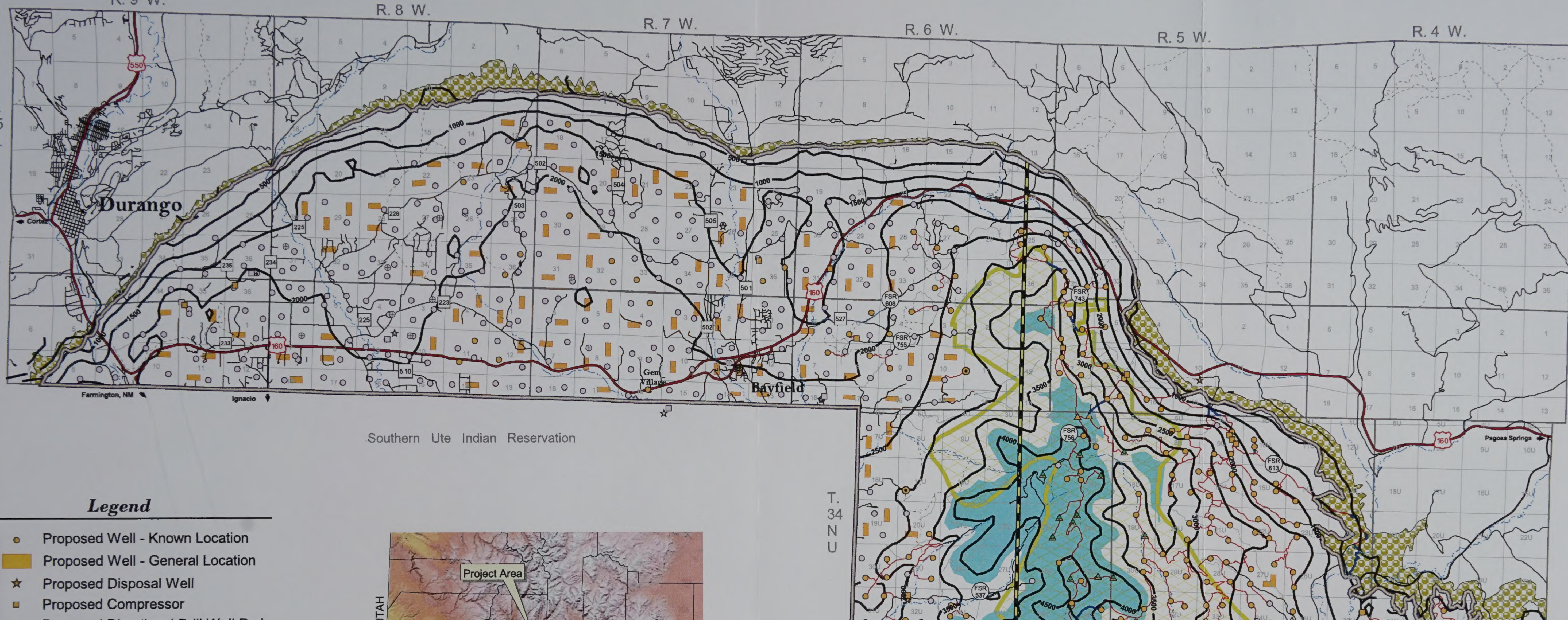
Table 2-13 Summary of Effects, by Alternative

	Alternative				
	1	2	5	6	7
ISSUE					
Noise					
Impact of day and nighttime noise levels associated with construction, drilling, and operation of CBM facilities.	Construction noise levels would be below Colorado Oil and Gas Conservation Commission (COGCC) standards 100 feet from the activities. Drilling noise would be below COGCC standards at 1,800 feet during the day and 3,000 feet during the night. Pump jack noise would be below COGCC noise standards at 150 feet during the day and 375 feet during the night. Compressor station noise would be below COGCC standards at 350 feet during the day and 650 feet during the night. Five new compressor stations could be located within 650 feet of Noise Sensitive Areas (NSAs) in the western portion of the Project Area. Additional setbacks from these NSAs may be required. In addition, 69 pump jacks could operate near established or proposed residential areas. Additional setbacks may be required to meet COGCC noise standards. National Forest CBM development would generally not occur within proximity of residences. There are scattered residences in the Sauls Creek area within proximity to well sites and a few residences in the Fosset Gulch area, also within proximity of proposed CBM development. National Forest CBM development would meet all applicable noise standards. BLM development would be limited to 12 wells drilled in areas of mixed jurisdiction. The BLM wells would be sited to avoid violation of applicable noise standards.	Five new compressor stations could be within 650 feet of noise sensitive areas in the western portion of the Project Area. Additional setbacks from these NSAs may be required. In addition, 95 pump jacks could operate near established or proposed residential areas. Additional setbacks may be required to meet COGCC noise standards.	In total, 52 pump jacks could operate near established or proposed residential areas. Additional setbacks may be required to meet COGCC noise standards. Three new compressor stations could be within 650 feet of NSAs in the western portion of the Project Area. Additional setbacks from these NSAs may be required. There would be no well development on federal mineral estate, thus no contribution of federal wells to noise conflicts.	In total, 72 pump jacks could operate near established or proposed residential areas. Additional setbacks may be required to meet COGCC noise standards. Five new compressor stations could be within 650 feet of NSAs in the western portion of the Project Area. Additional setbacks from these NSAs may be required. National Forest CBM development would generally not occur within proximity of residences. There are scattered residences in the Sauls Creek area within proximity to well sites and a few residences in the Fosset Gulch area. National Forest CBM development would meet all applicable noise standards. BLM development would be limited to 12 wells drilled in areas of mixed jurisdiction. The BLM wells would be sited to avoid violation of applicable noise standards.	In total, 67 pump jacks could operate near established or proposed residential areas. Additional setbacks may be required to meet COGCC noise standards. Five new compressor stations could be within 650 feet of NSAs in the western portion of the Project Area. Additional setbacks from these NSAs may be required. National Forest CBM development would generally not occur within proximity of residences. There are scattered residences in the Sauls Creek area within proximity to well sites and a few residences in the Fosset Gulch area. National Forest CBM development would meet all applicable noise standards. BLM development would be limited to 12 wells drilled in areas of mixed jurisdiction. The BLM wells would be sited to avoid violation of applicable noise standards.
Effect of cavitation and fracturing operations on sensitive receptors such as outdoor living space around residences.	One hundred percent of wells would be fracture stimulated in the eastern portion of the Project Area. On the western side, 75 percent of the wells would be fractured and 25 percent cavitated to stimulate production. Noise effects from fracturing would not be noticeable because of the depth of this activity. However, short bursts of noise would be noticeable from cavitation, but this impact would be experienced over a 2-week period for any given site and only during the day.	Impacts would be similar to Alternative 1.	There would be no impact within the National Forest portion of the Project Area, but impacts similar to Alternative 1 within the rest of the Project Area.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Social and Economic					
Impacts of CBM development on tourism and tourism revenues and the sales tax revenue, employment, and income tax proceeds derived from tourism.	CBM and conventional gas development has not affected tourism and is unlikely to affect tourism during the life of the project.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Potential for creating a boom or bust economy.	Revenues, jobs, and personal income would likely peak by the year 2010 and gradually decline until gas production ends about 2040. Although CBM revenues and jobs would gradually decrease, the population is projected to grow steadily. Long-term growth and diversification would likely somewhat offset the gradual decline in CBM revenues.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Environmental costs of drilling on federal lands.	The environmental effects of CBM development are described throughout the EIS. Many of these impacts are non-quantifiable, even in terms of the opportunity costs of CBM development	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.	Impacts would be similar to Alternative 1.
Impact of continued CBM development on county revenues from gas royalties and taxes. Effect on sales and taxes.	County revenues would be in the form of *ad valorem* property taxes. It is estimated that La Plata County would receive $33 million over the life of the project, and Archuleta County would receive $15 million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.	It is estimated that La Plata County would receive $74 million in *ad valorem* tax over the life of the project, and Archuleta County would receive $20 million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.	It is estimated that La Plata County would receive $23 million in *ad valorem* tax over the life of the project, and Archuleta County would receive $2 million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.	County revenues would be in the form of *ad valorem* property taxes. It is estimated that La Plata County would receive $33 million over the life of the project, and Archuleta County would receive $3million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.	County revenues would be in the form of *ad valorem* property taxes. It is estimated that La Plata County would receive $33 million over the life of the project, and Archuleta County would receive $9 million. Sales tax revenues would be minimal because most of the purchases of CBM equipment and personal purchases by employees would be outside of the counties.
Impacts of CBM development on demographics, employment, and infrastructure.	Employment associated with CBM development would be 2 percent of total employment. CBM development would generate 930 new jobs.	Employment associated with CBM development would c be 3.5 percent of total employment. CBM development would generate 1,630 new jobs.	Employment associated with CBM development would be 1-percent of total employment. CBM development would generate 380 new jobs	Employment associated with CBM development would be 1.5-percent of total employment. CBM development would generate 575 new jobs	Employment associated with CBM development would be 2 -percent of total employment. CBM development would generate 750 new jobs
Effect of gas wells on residential property values.	Property values have increased by about 7 percent per year during the past decade. Some property values may decrease in close proximity to wells. BLM mineral estate/private surface would be limited to 12 wells. Any one of those wells may potentially impact property values because they would be constructed in mixed ownership areas of the western Project Area. In contrast, National Forest wells would generally be isolated from residences and thus would not impact property values. The two exceptions are federal wells drilled within the Sauls Creek area and the Fosset Gulch area. There are scattered private lands and residences in both areas. The property values of residences and vacant land in these areas would be potentially impacted by National Forest CBM development	The property value of more residences may be affected as a result of Alternative 2 due to the higher number of wells drilled within proximity of private property and residences.	There would be no federal CBM wells developed under this Alternative and thus no impact of federal well development on property values.	Effects would be similar to Alternative 1. CBM well development on BLM lands and BLM mineral estate/private surface would be limited to 12 wells. Any one of those wells may potentially impact property values because they would be constructed in mixed ownership areas of the western Project Area. In contrast, National Forest wells would generally be isolated from residences and thus would have no impact on property values. The two exceptions are federal wells drilled within the Sauls Creek area and the Fosset Gulch area. There are a scattered private land and residences in both areas whose property values would be potentially impacted by National Forest CBM development	Effects would be similar to Alternative 1. CBM well development on BLM lands and BLM mineral estate/private surface would be limited to 12 wells. Any one of those wells may potentially impact property values because they would be constructed in mixed ownership areas of the western Project Area. In contrast, National Forest wells would generally be isolated from residences and thus would have no impact on property values. The two exceptions are federal wells drilled within the Sauls Creek area and the Fosset Gulch area. In both areas there are a scattered private land and residences whose property values would be potentially impacted by National Forest CBM development
Health and Safety					
Risks to human health associated with underground coal fires.	Risk of ignition or re-ignition of coal fires would be low to moderate.	Risk would be moderate because of the greater number of wells and the wells drilled near the outcrop.	Impacts would be similar to Alternative 1 in the western Project Area and low in the eastern Project Area because no wells would be drilled on federal mineral estate. Well development in the eastern Project Area would be limited to 14 private wells and 2 state wells.	Risk of ignition or re-ignition of coal fires would be low to moderate.	Risk of ignition or re-ignition of coal fires would be low to moderate.

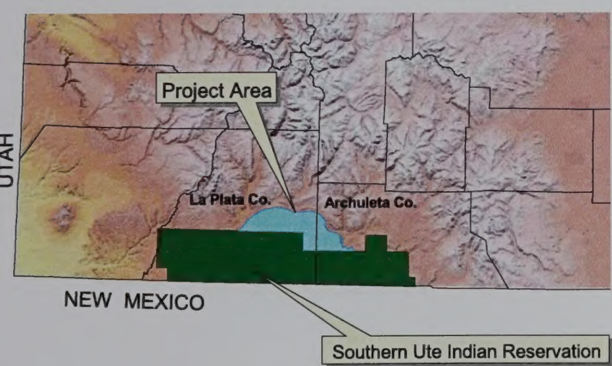
Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Health risks of hydrogen sulfide seeps.	Since the overwhelming majority of existing CBM wells do not contain hydrogen sulfide, the risk of exposure is extremely low.	Because of the wells proposed near the outcrop, the risk would be rated marginally higher than Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Potential for accidental spills from generation, handling, and storage of hazardous and nonhazardous chemicals and wastes.	The risk of a spill would be proportional to the amount of chemicals and hazardous materials transported, stored, and used. The operator's adherence to regulations and their environmental health and safety plans would minimize the potential for spills.	Effects would be similar to Alternative 1 but marginally higher because of the development of more wells in Alternative 2.	Effects would be similar to Alternative 1 but much less in the eastern Project Area because federal mineral estate would not be developed.	Effects would be similar to Alternative 1 but less because of fewer wells developed on federal mineral estate in the HD Mountains.	Effects would be similar to Alternative 1 but slightly less because of fewer wells would be developed on federal mineral estate within three zones of the HD Mountains.
Effects of chemicals used as treatments for project roads (magnesium chloride).	The State of Colorado and U.S. Environmental Protection Agency (EPA) have approved application of magnesium chloride for dust suppression on roads. Because no adverse health effects from magnesium chloride have been noted, the benefits of dust suppression outweigh any minimal adverse effect of magnesium chloride.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Risks of well flaring.	Flaring increases the risk for wild fires when compared with venting methane. Clearing brush and vegetation near flaring reduces the risk for fires. During periods of high fire risk, the agencies issue strict fire prevention that further reduces the risk of fire.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.
Potential for fire or explosion of CBM wells.	Standard safety procedures for drilling, pipeline route markers, monitoring, and inspections are required to minimize the probability of a well blowout, undetected gas leak, or well fire. Adherence to these procedures and development of emergency plans with defined fire prevention and fire fighting procedures minimize the risk.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.	Effects would be similar to Alternative 1.

Table 2-13 Summary of Effects, by Alternative					
	Alternative				
	1	2	5	6	7
ISSUE					
Air Quality					
The effect of additional CBM development on air quality.	No significant, adverse air quality impacts are anticipated from implementation of Alternative 1. Although the restrictive State of Colorado's 3-hr sulfur dioxide standard of 700 $\mu g/m^3$ was predicted to be exceeded (at 702 $\mu g/m^3$) during construction, given the "reasonable, but conservative" assumptions applied in this analysis, no violations of any applicable local, state, tribal or federal ambient air quality standard are likely to actually occur. Applicable PSD Class I and II increments were not predicted to be exceeded. Potential atmospheric deposition impacts (and resulting changes in sensitive lake chemistry) were predicted to be below applicable thresholds. A direct 'just noticeable change" in visibility was not predicted to occur at Mesa Verde National Park on any day, but would occur on between 0 and 3 days per year at the Weminuche Wilderness Area. However, given the reasonable, but conservative assumptions incorporated into this analysis, these direct impacts are not likely to actually occur.	No significant, adverse impacts to air quality are anticipated from implementation of Alternative 2. Although the restrictive State of Colorado's 3-hr sulfur dioxide standard of 700 $\mu g/m^3$ was predicted to be exceeded (at 702 $\mu g/m^3$) during construction, given the "reasonable, but conservative" assumptions applied in this analysis, no violations of any applicable local, state, tribal or federal ambient air quality standard are likely to actually occur. Applicable PSD Class I and II increments were not predicted to be exceeded. Potential atmospheric deposition impacts (and resulting changes in sensitive lake chemistry) were predicted to be below applicable thresholds. A direct 'just noticeable change" in visibility was not predicted to occur at Mesa Verde National Park on any day, but would occur on between 0 and 3 days per year at the Weminuche Wilderness Area. However, given the "reasonable, but conservative" assumptions incorporated into this analysis, these direct impacts are not likely to actually occur.	No significant, adverse impacts to air quality are anticipated from implementation of Alternative 5	Given the lower number of potential well pad locations, overall air quality impacts would be somewhat less than those for Alternative 1, although the maximum predicted air quality impacts associated with CBM operations would be very similar.	Air quality impacts would be similar to Alternative 1.



Legend

- Proposed Well - Known Location
- Proposed Well - General Location
- Proposed Disposal Well
- Proposed Compressor
- Proposed Directional Drill Well Pad
- Proposed Vertical Well on Directional Pad
- Horizontal Well
- Proposed Flowline
- Proposed Access Road/Flowline
- Existing Well
- Existing Disposal Well
- Existing Compressor
- Project Area Boundary
- U.S. Highway
- Primary Road
- Secondary Road
- Closed USFS Road
- Trail
- River/Stream
- Depth Contour
- HD Mountain Rare II Area
- Reach >1320 Feet
- Fruitland Outcrop



N
W E
S

2 0 2 4 6 8 Kilometers

2 0 2 4 6 8 Miles

La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data. Existing wells extracted from COGCC well database and edited by the BLM & USFS.

Transverse Mercator Projection
1927 North American Datum
Zone 13

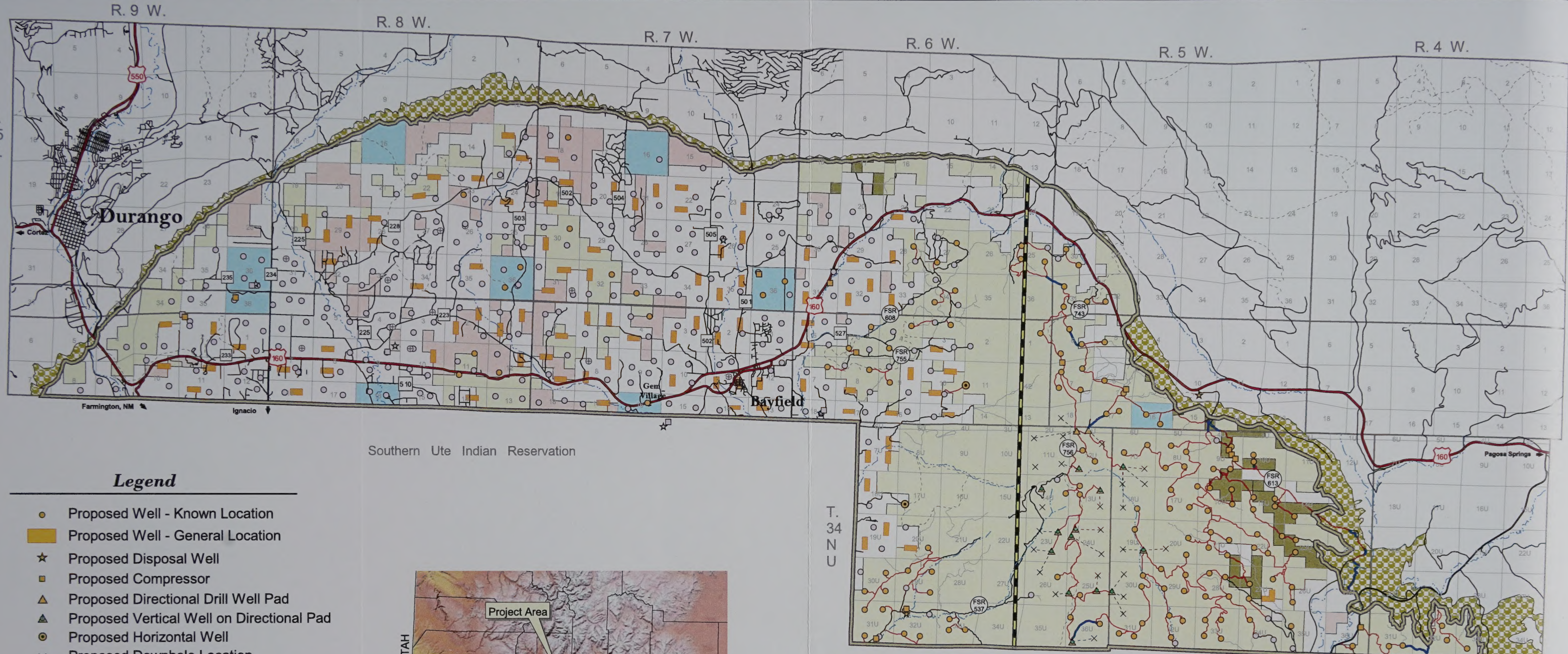
NORTHERN SAN JUAN BASIN CBM FEIS

FIGURE 2-1
DEPTH TO TOP OF FRUITLAND FORMATION & COMPANIES' PROPOSED ACTION

ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO

Date: 12/15/05 | ArcView File: C:\994-sanjuan\proposal.apr

Prepared By: JG

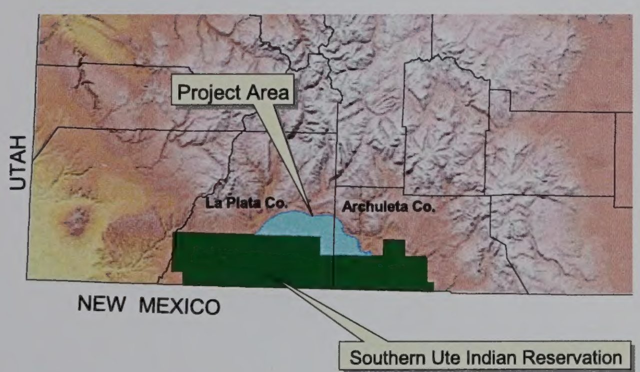


Legend

- Proposed Well - Known Location
- Proposed Well - General Location
- Proposed Disposal Well
- Proposed Compressor
- Proposed Directional Drill Well Pad
- Proposed Vertical Well on Directional Pad
- Proposed Horizontal Well
- Proposed Downhole Location
- Proposed Flowline
- Proposed Access Road/Flowline
- Proposed Directional Drill Path
- Existing Well
- Existing Disposal Well
- Existing Compressor
- Project Area Boundary
- U.S. Highway
- Primary Road
- Secondary Road
- Closed USFS Road
- Trail
- River/Stream

Surface Ownership/Mineral Ownership

- Federal/Federal
- Federal/Private
- Private/Private
- Private/Federal
- State/State
- Fruitland Outcrop



2 0 2 4 6 8 Kilometers

2 0 2 4 6 8 Miles

La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data. Existing wells extracted from COGCC well database and edited by the BLM & USFS.

Transverse Mercator Projection
1927 North American Datum
Zone 13

NORTHERN SAN JUAN BASIN CBM FEIS

FIGURE 2-2
ALTERNATIVE 1
COMPANIES' PROPOSED ACTION

ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO

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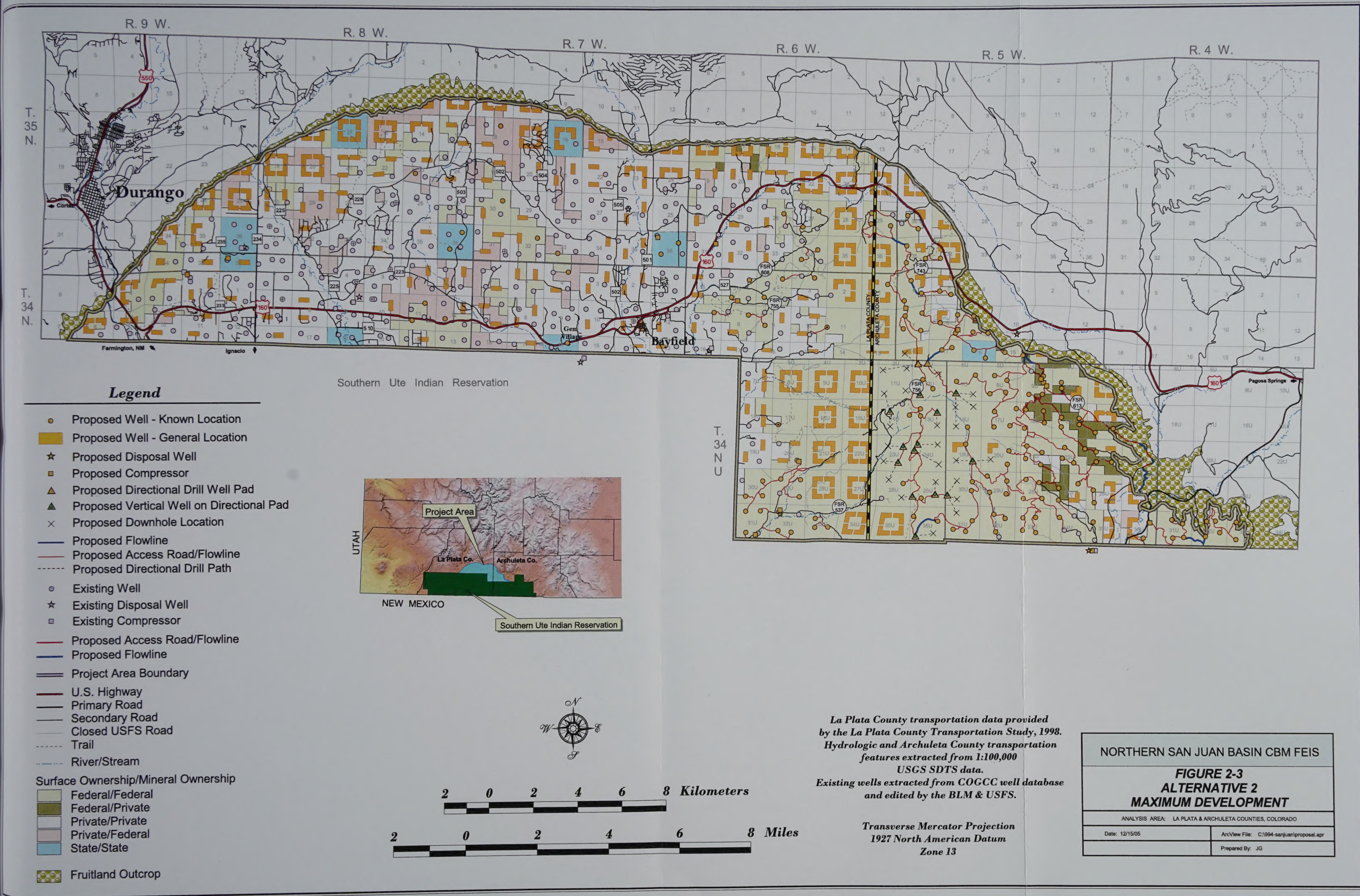
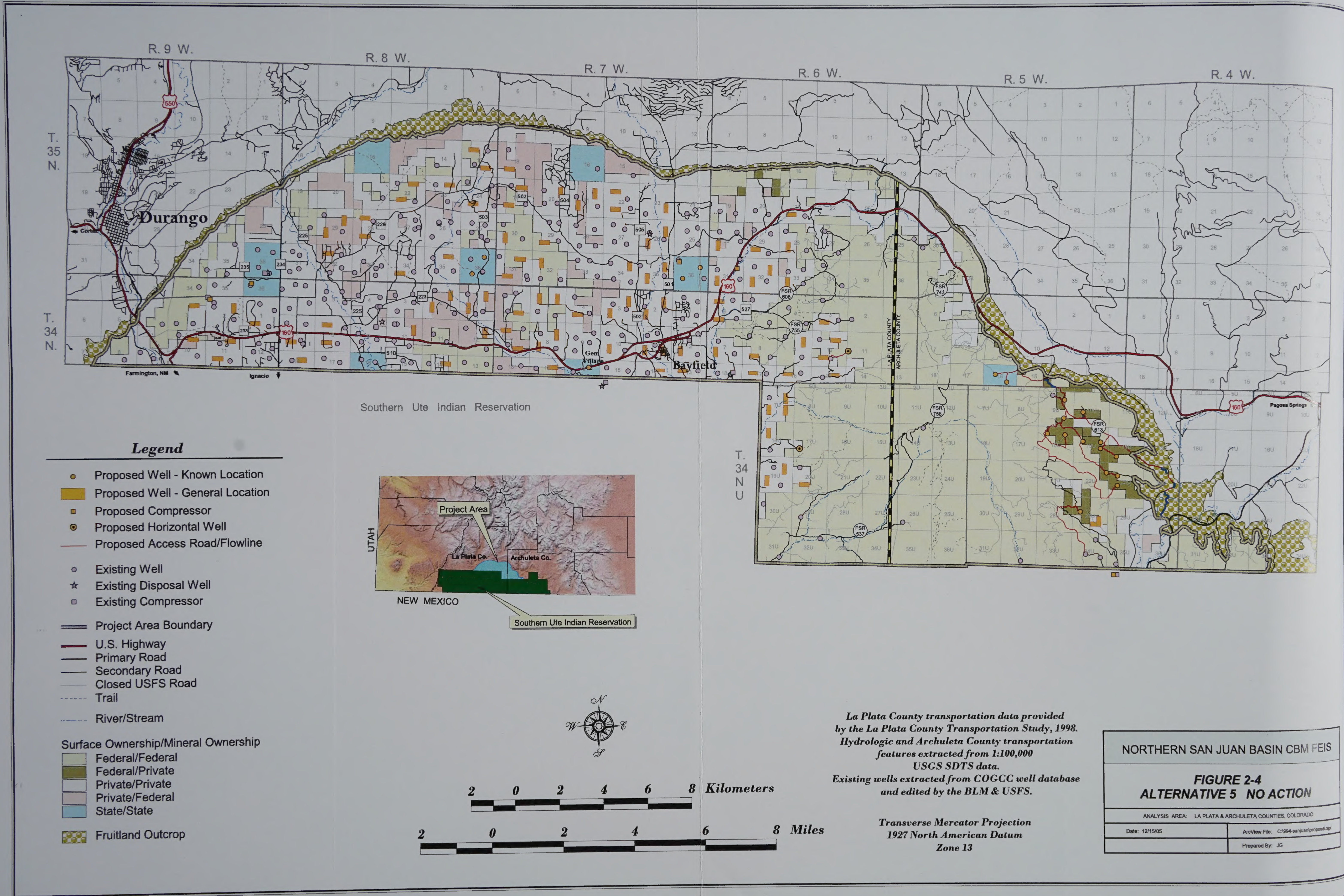
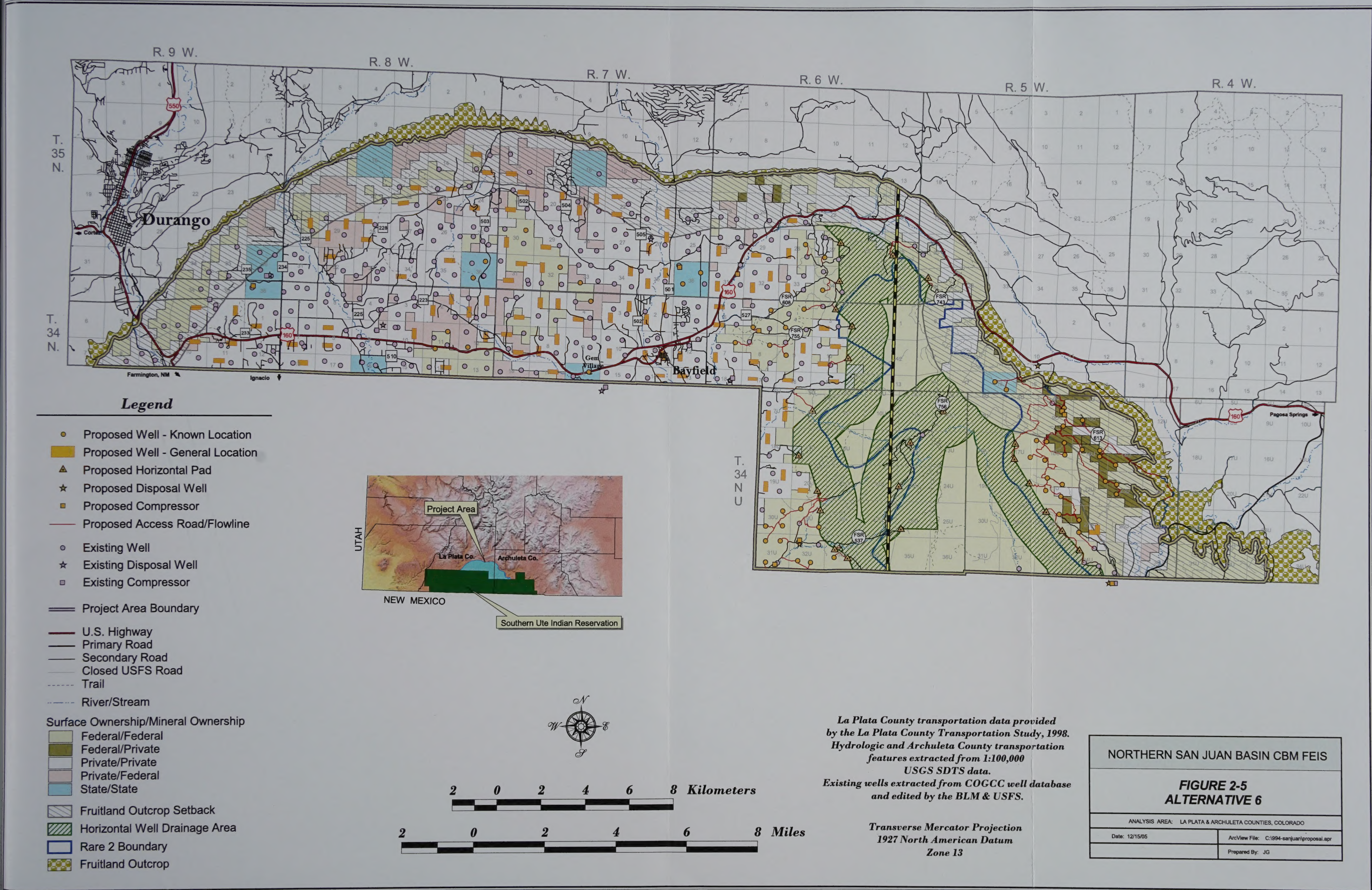


R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
T. 35 N.
T. 34 N.
T. 34 N U
Durango
Bayfield
Gem Village
Farmington, NM
Ignacio
Cortez
Pagosa Springs
Southern Ute Indian Reservation
LA PLATA COUNTY
ARCHULETA COUNTY
Legend
Proposed Well - Known Location
Proposed Well - General Location
Proposed Disposal Well
Proposed Compressor
Proposed Directional Drill Well Pad
Proposed Vertical Well on Directional Pad
Proposed Downhole Location
Proposed Flowline
Proposed Access Road/Flowline
Proposed Directional Drill Path
Existing Well
Existing Disposal Well
Existing Compressor
Proposed Access Road/Flowline
Proposed Flowline
Project Area Boundary
U.S. Highway
Primary Road
Secondary Road
Closed USFS Road
Trail
River/Stream
Surface Ownership/Mineral Ownership
Federal/Federal
Federal/Private
Private/Private
Private/Federal
State/State
Fruitland Outcrop
Project Area
UTAH
La Plata Co.
Archuleta Co.
NEW MEXICO
Southern Ute Indian Reservation
2 0 2 4 6 8 Kilometers
2 0 2 4 6 8 Miles
La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data. Existing wells extracted from COGCC well database and edited by the BLM & USFS.
Transverse Mercator Projection
1927 North American Datum
Zone 13
NORTHERN SAN JUAN BASIN CBM FEIS
FIGURE 2-3
ALTERNATIVE 2
MAXIMUM DEVELOPMENT
ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO
Date: 12/15/05
ArcView File: C:\994-sanjuan\proposal.apr
Prepared By: JG



R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
T. 35 N.
T. 34 N.
T. 34 N U
Durango
Bayfield
Gem Village
Farmington, NM
Ignacio
Cortez
Pagosa Springs
Southern Ute Indian Reservation
LA PLATA COUNTY
ARCHULETA COUNTY
Legend
Proposed Well - Known Location
Proposed Well - General Location
Proposed Compressor
Proposed Horizontal Well
Proposed Access Road/Flowline
Existing Well
Existing Disposal Well
Existing Compressor
Project Area Boundary
U.S. Highway
Primary Road
Secondary Road
Closed USFS Road
Trail
River/Stream
Surface Ownership/Mineral Ownership
Federal/Federal
Federal/Private
Private/Private
Private/Federal
State/State
Fruitland Outcrop
Project Area
UTAH
La Plata Co.
Archuleta Co.
NEW MEXICO
Southern Ute Indian Reservation
N
W
E
S
2 0 2 4 6 8 Kilometers
2 0 2 4 6 8 Miles
La Plata County transportation data provided by the La Plata County Transportation Study, 1998.
Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data.
Existing wells extracted from COGCC well database and edited by the BLM & USFS.
Transverse Mercator Projection
1927 North American Datum
Zone 13
NORTHERN SAN JUAN BASIN CBM FEIS
FIGURE 2-4
ALTERNATIVE 5 NO ACTION
ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO
Date: 12/15/05
ArcView File: C:\994-sanjuan\proposal.apr
Prepared By: JG



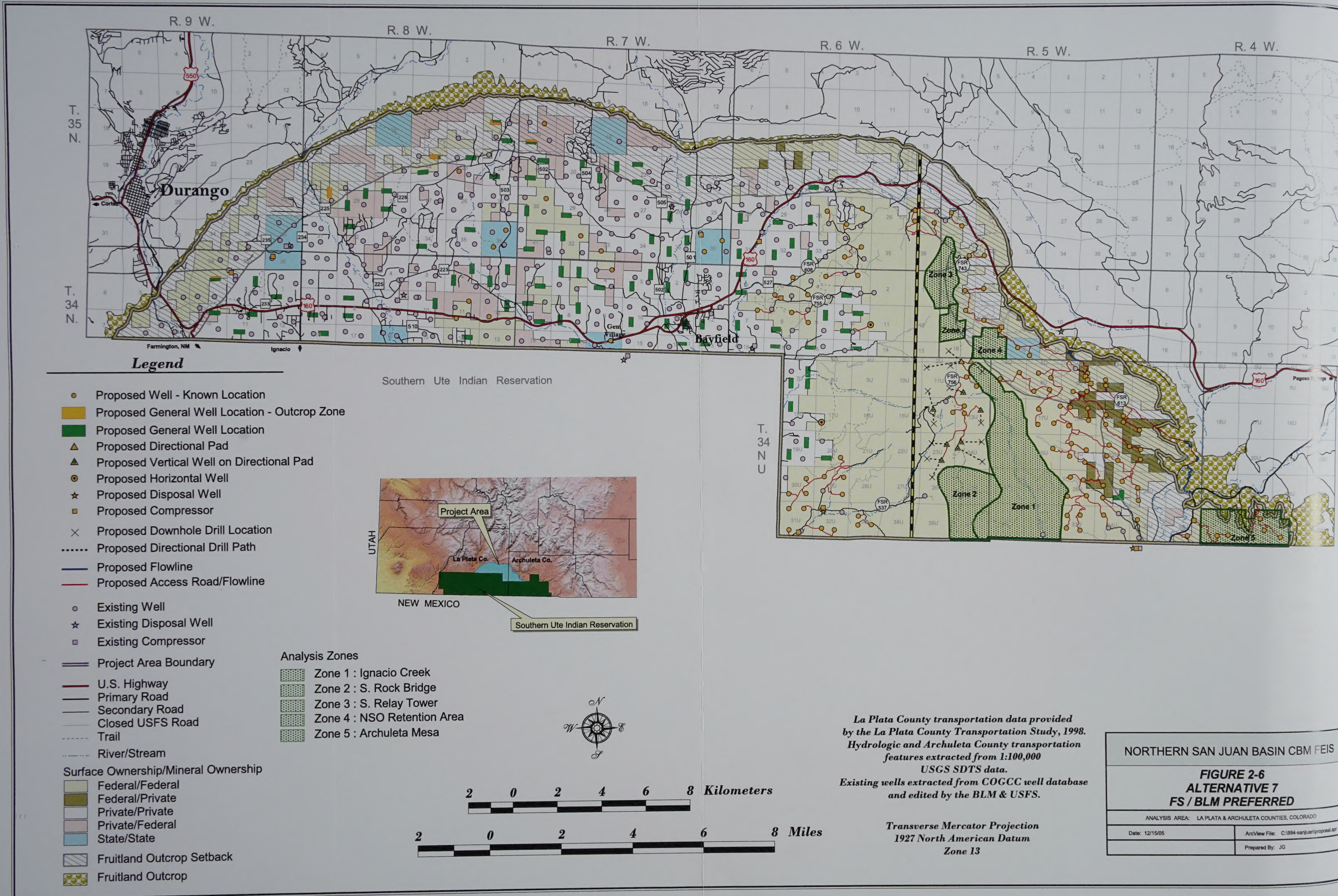
NORTHERN SAN JUAN BASIN CBM FEIS

FIGURE 2-5
ALTERNATIVE 6

ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO

Date: 12/15/05 | ArcView File: C:\994-sanjuan\proposal.apr

Prepared By: JG


R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
T. 35 N.
T. 34 N.
T. 34 N U
Durango
Bayfield
Southern Ute Indian Reservation
Legend
Proposed Well - Known Location
Proposed General Well Location - Outcrop Zone
Proposed General Well Location
Proposed Directional Pad
Proposed Vertical Well on Directional Pad
Proposed Horizontal Well
Proposed Disposal Well
Proposed Compressor
Proposed Downhole Drill Location
Proposed Directional Drill Path
Proposed Flowline
Proposed Access Road/Flowline
Existing Well
Existing Disposal Well
Existing Compressor
Project Area Boundary
U.S. Highway
Primary Road
Secondary Road
Closed USFS Road
Trail
River/Stream
Surface Ownership/Mineral Ownership
Federal/Federal
Federal/Private
Private/Private
Private/Federal
State/State
Fruitland Outcrop Setback
Fruitland Outcrop
Project Area
UTAH
La Plata Co.
Archuleta Co.
NEW MEXICO
Southern Ute Indian Reservation
Analysis Zones
Zone 1 : Ignacio Creek
Zone 2 : S. Rock Bridge
Zone 3 : S. Relay Tower
Zone 4 : NSO Retention Area
Zone 5 : Archuleta Mesa
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
2 0 2 4 6 8 Kilometers
2 0 2 4 6 8 Miles
La Plata County transportation data provided by the La Plata County Transportation Study, 1998. Hydrologic and Archuleta County transportation features extracted from 1:100,000 USGS SDTS data. Existing wells extracted from COGCC well database and edited by the BLM & USFS.
Transverse Mercator Projection
1927 North American Datum
Zone 13
NORTHERN SAN JUAN BASIN CBM FEIS
FIGURE 2-6
ALTERNATIVE 7
FS / BLM PREFERRED
ANALYSIS AREA: LA PLATA & ARCHULETA COUNTIES, COLORADO
Date: 12/15/05
Prepared By: JG

Chapter 3
Affected Environment and Environmental Consequences

Chapter 3 — Affected Environment and Environmental Consequences

This chapter describes the affected environment and probable environmental consequences of the alternatives evaluated in detail. The environmental analysis focuses on issues identified through the scoping process.

The affected environment, which is the portion of the existing environment that could be affected by the project, varies for each resource and issue. Both the nature of the issues and the components of the proposed action and alternatives dictate this variation.

An "environmental effect" or "consequence" is defined as "a modification of or change in the existing environment brought about by the action taken." Effects are direct, indirect, or cumulative and may be temporary (short term) or permanent (long term). Effects can vary in degree, ranging from only a slightly discernible change to a drastic alteration in the environment. This analysis considers short-term effects to be any that would occur during the Project's construction and drilling phases. Long-term effects are residual effects that persist during the production phase of the Project.

The geographic scope of this analysis is defined by public and internal issues and concerns. The public and elected officials have requested the FS and BLM to take a comprehensive, hard look at CBM development within the defined Project Area, giving equal treatment to CBM development impacts on non-federal jurisdictions within their boundaries. They have also requested that the FS and BLM evaluate from a cumulative standpoint, the combined effects of Project Area CBM development and CBM development that is occurring within the bounds of the Southern Ute Indian (SUIT) Reservation. We have attempted to frame our analysis around this request.

Attention is given to describing the environmental consequences on each jurisdiction (e.g. national forest, BLM, state etc) where such distinctions can be made. However, because CBM development is occurring simultaneously on federal, state, and private mineral estate, land areas and impacts are intermingled and for some resources it is difficult to apportion the cause of impact to any particular jurisdiction. This is particularly true of Fruitland Formation outcrop impacts, and groundwater, and air quality impacts. In such cases, we have analyzed CBM development on all jurisdictions as a single entity and causative factor and have attempted to apportion the jurisdictional cause of impacts only in a general manner where possible.

For the purposes of structuring this analysis we have chosen to treat all CBM development activities within the Project Area as generating direct and indirect environmental consequences and those occurring outside the Project Area as contributing to cumulative environmental consequences. Non-federal land impacts

are evaluated in equal detail within the Project Area to fully disclose overall effects of CBM development to the human environment and to support the environmental permitting of other agencies that have jurisdiction within the Project Area. The BLM and FS project decisions apply to federal jurisdiction only.

Each resource section in this chapter addresses:

- Resource specific issues
- Affected environment.
- Environmental consequences (direct and indirect effects).
- Cumulative effects.
- Monitoring and mitigation.
- Unavoidable adverse effects.
- Irreversible and irretrievable commitments of resources.

Direct effects are those caused by CBM development and that occur at the same time and place. Indirect effects are those caused by CBM development and are later in time or further removed in distance, but are reasonably foreseeable.

Cumulative effects are the impacts to the environment that result from the incremental impact of the action (CBM development) when added to other past, present and reasonably foreseeable future actions (RFFAs) regardless of what agency (Federal or non-Federal) or person undertakes such other actions. RFFAs include activities, developments, or events that have the potential to change the physical, social, economic, and/or biological nature of a specified area. Existing activities, projected activities directly associated with a proposed action, and other RFFAs provide the basis for defining and analyzing future cumulative impacts. Cumulative effects are addressed in each resource section that follows. They are then summarized at the end of Chapter 3.

Mitigation is the action the agency would take to either avoid an impact altogether, or to reduce an impact, rectify an impact, or compensate for an impact by replacing or providing substitute resources or environments.

Unavoidable adverse effects are impacts that cannot be avoided through the application of alternatives and mitigation should the proposal be implemented.

An irreversible commitment of resources refers primarily to the effects of use of non-renewable resources such as minerals or cultural resources, or to those factors such as soil productivity that are renewable only over long periods of time. An irretrievable commitment applies to the loss of production. For example, all or part of a well pad is lost to prior uses as the pad serves CBM gas development for an extended period.

The following reasonable foreseeable future actions work synergistically to produce the cumulative impacts analyzed in this EIS.

3.1 Actions Contributing To Cumulative Effects

3.1.1 Cumulative Effects Analysis Area

The general cumulative effect analysis area for most resource analyses is the Project Area (125,000 acres) and that portion of the Southern Ute Indian Reservation that has and will continue to experience CBM development over the next decade (422,000 acres). The cumulative effects analysis area is therefore 547,000 acres, encompassing the Colorado portion of the SJB. The water, economic, and air quality cumulative effects analysis area, however, extends into New Mexico and includes foreseeable oil and gas development within the BLM Farmington Resource Area and Jicarilla Ranger District, Carson National Forest.

The cumulative effect analysis considers the environmental consequences of oil and gas development. Other activities analyzed that may contribute to cumulative impacts include rural and urban housing development, timber harvest, fire management, livestock grazing, recreation, agriculture, and road construction (Table 3-1).

Table 3-1 Categories of Actions included in Cumulative Effects Analysis

General Category of Activity	Amount	Year	Resource of Concern
Past and Present Actions			
Oil and Gas Development	Acres or miles of disturbance	Year or period in which activity occurred	All
Community Expansion			Wildlife, land use, recreation, transportation, social and economic values
Timber Harvest and Fire			Wildlife, water, soils, vegetation
Livestock Grazing			Wildlife, water, soils, vegetation
Recreation			Wildlife, transportation
Reasonably Foreseeable Future Actions			
Oil and Gas Development	Acres or miles of disturbance	Year or period in which activity occurred	All
Community Expansion			Wildlife, land use, recreation, transportation, social and economic values
Timber Harvest and Fire			Wildlife, water, soils, vegetation
Livestock Grazing			Wildlife, water, soils, vegetation
Recreation			Wildlife, transportation

3.1.2 Oil and Gas Development

Oil and gas development is projected to continue both within and south of the Project Area. The Proposed Action involves drilling of 185 additional CBM wells from 162 well pads on federal jurisdiction within the Project Area. Contributing to environmental consequences is the proposed drilling of 99 wells on private and state minerals over the next decade within the Project Area, as described in Chapter 2, Table 2-9. Therefore, new drilling activity would equal 284 new CBM wells drilled from 261 well pads within the Project Area. South of the Project Area, within the bounds of the Southern Ute Reservation, 636 additional gas wells, 70 injection wells for enhanced coal bed methane projects, and associated facilities are projected for Tribal minerals and 586 wells are projected for non-tribal minerals. Other reasonably foreseeable oil and gas development includes

development in the New Mexico portion of the SJB. Table 3-2 provides a tabulation of oil and gas development within the cumulative effects area, broken out by (1) current development within the Project Area, (2) projected CBM development on federal mineral estate within the Project Area, (3) projected CBM development on all jurisdictions within the Project Area, (4) total past and projected well development on all jurisdictions within the Project Area, and (5) total past and projected well development within the cumulative effects area for two development scenarios — the proposed action and maximum development within the NSJB. Within New Mexico, the FEIS for the Farmington Resource Area RMP projects development of 9,900 new wells over the next 20 years, drilled at a rate of about 500 wells per year. This level of regional development is important when assessing economic, water, and air quality impacts. The cumulative effects area for most other resources is more localized due to a lack of interaction of resources between the two regions defined by northern New Mexico and Southwest Colorado.

Table 3-2 Cumulative Summary of Existing and Projected Oil and Gas Development

Parameter	Existing	Proposed Action	Maximum Development
CBM Development on Federal Mineral Estate within the Project Area (New development)			
Well Pads (number)	49	162	301
Short-Term Disturbance (acres)	200	788	1,293
Long-term Disturbance (acres)	156	487	833
Roads/Pipelines (total length in miles)	21	97	162
CBM development on all Jurisdictions within the Project Area (New development)			
Well Pads (number)	290	261	491
Short-Term Disturbance (acres)	660	1,091	1,878
Long-term Disturbance (acres)	505	665	1,197
Roads/Pipelines (total length in miles)	58	116	202
CBM development on all Jurisdictions within the Project Area (existing + new development)			
Within Project Area			
Well Pads (number – CBM and conventional)	290	551	781
Short-Term Disturbance (acres)	660	1,751	2,538
Long-term Disturbance (acres)	505	1,170	1,702
Roads/Pipelines (total length in miles)	58	174	260
CBM development on all Jurisdictions within the Colorado Portion of the San Juan Basin (existing + new)			
Existing and Projected within the bounds of the SUIT Reservation			
Well Pads (number – CBM and conventional)	3,240	3,810	4,040
Total Disturbance (acres)	14,900	20,600	21,300
Roads/Pipelines (total length in miles)	485	1,185	1,270

The SJB is already substantially developed for oil and gas production. Today there are more than 26,000 wells in the SJB operated by dozens of operators. Within the Colorado portion of the SJB, there are approximately 2,500 wells in operation. Where the productive trends in different geologic formations overlap

or where oil is produced in New Mexico, there are often more than a dozen wells in a single 640-acre section. In less prospective areas, there are only one or two producing wells in a section.

This level of development presented above when taken with existing development, presents concerns about degradation of wildlife habitat effectiveness, impacts to the area's visual quality, the potential for reduced property values, impacts to recreational settings and opportunities, noise conflicts, depletions of surface waters, and various health and safety issues, particularly at the Fruitland Formation outcrop.

3.1.3 Community Expansion

Community expansion has and will continue to contribute to cumulative impacts. Community Expansion in La Plata County is expected to include growth in the residential population, related increases in commercial operations and development of county roads, and small industrial developments unrelated to mineral resources. No major industrial project, such as a power plant or new factory, is foreseen in La Plata County. Instead, community growth is expected to be based on influx of individuals, families, and retirees attracted to the Four Corners area life style. The economy of the cumulative effects area and other nearby counties is predicted to expand but to stay distributed over the same industries that comprise it now. Population will continue to be concentrated in the communities of Durango, Bayfield, and Ignacio, but residential development will also continue to encroach on agricultural and forested lands and on oil and gas production facilities, especially in the central and northern parts of the La Plata County. Gas development is already spread throughout the area where the San Juan Basin overlaps the County. Residential development in those areas will in many places coexist with gas well development.

Southwestern Colorado is generally growing faster than most areas of the country. According to the Florida Mesa and Bayfield District Land Use Plans, population growth rates of more than 3 percent per year were recorded during 1992 to 1996 (La Plata County Planning Department 1997, 1998). Neither La Plata nor Archuleta Counties have any burgeoning industry, which would cause people to move there for job opportunities. In fact, the opposite appears to be true: people move to the area despite poor job prospects because they value the non-urban lifestyle and recreational opportunities of the Four Corners area. Some new residents are independent of the local economy; for example retirees and telecommuters. The populations of La Plata and Archuleta Counties, particularly within the rural areas, will continue to grow as long as the current community attributes are maintained.

The gas industry along with other base industries contributes cumulatively to local jobs, income, and the local county revenues. Tourism will continue to be a vibrant and visible piece of the economy (hotels and motels, restaurants, Purgatory ski area, resorts, gift shops, and other recreational services). The SUIT will remain one of the largest single employers in the area, continuing to fund Tribal activities and ventures primarily with current energy revenues and earnings on invested revenues. Approximately half of the Tribe's employees work at the

Tribe's Sky Ute Casino, which funds itself and funnels earnings back to the Tribe. Fort Lewis College, the public school districts, and the Mercy Medical Center are also predicted to remain large employers in the area, growing in service to the area's growing population. The oil and gas industry will decline in the future with depletion of reserves and the associated decline of operations and investments.

The increase in broadly spaced, rural residential development in La Plata and Archuleta Counties is recognized as a problem on several counts. First, it reduces wildlife habitat. Second, it increases the cost of providing basic services, to residents such as roads and bridges, water, sewage control, electricity, and natural gas. Third, it degrades scenic views. "Current subdivision practices are developing the counties into smaller and smaller lots, gradually eroding the very qualities that attracted most residents." Finally, subdivision has increased the potential for conflict between residents and gas industry development. La Plata County government is promoting the development of district plans, which include substantial input from the district residents, and both the State and La Plata County have regulated the oil and gas industry to address residential development issues.

Community expansion will impact biological resources by changing land use and compromising habitat. Houses and new roads take away grazing and forage areas. Roads threaten migration routes, and animals of all types are often killed while attempting to cross roads. Human activity disturbs wildlife, can stress and weaken individual animals, and lowers reproduction rates. Community expansion will add noise, affect visual resources, decrease water quality and/or quantity, and add traffic. Expansion may affect soils by replacing agriculture with subdivisions. It should not affect geologic resources except by encouraging the development of gravel resources. It should be an overall positive socio-economic impact because of increased and maintained job opportunities, diversification of the employment base, and increased tax revenues to various taxing entities that in turn provide services to residents.

3.1.4 Timber Harvest and Fire

The effects of timber harvest and fire suppression are of concern in the SJNF portion of the cumulative effects area. Timber harvest, when taken with other vegetation or ground-disturbing activities such as oil and gas development, would cumulatively affect soils, water quality, recreation, and particularly wildlife and their habitats. Records of past timber harvest activity indicate that between 1941 and 1996, 6,870 acres of ponderosa pine and mixed conifer were harvested in the Project Area on NFS lands. Approximately 1,535 acres of ponderosa pine and Douglas-fir were converted by harvests to different vegetation types including grasslands (103 acres); mountain shrub (55 acres); sagebrush (237 acres); Gambel oak (895 acres); pinyon-juniper (214 acres); riparian (5 acres); and barren (26 acres). These treatments benefited early successional wildlife species to the detriment of those that thrive on older forested ecosystems. There are also periodic timber harvests and thinning of small tracts of private and Reservation lands that contribute to perpetuating younger age classes of ponderosa pine, as has been the case over most of the SJNF.

A recent SJNF timber sale straddles the northeastern border of the Project Area. Cutting activities were conducted the summer of 2003, commercially thinning 157 acres of ponderosa pine. After thinning, a 500-acre prescribed burn is planned to reduce fuels and enhance pine regeneration. There are three additional vegetation treatment projects that are in various stages of planning: the FS is reviewing ponderosa pine fuels reduction treatments in the Fosset Gulch, Sauls Creek, and Lange Canyon areas. None of these activities is expected to individually or cumulatively affect wildlife detrimentally, but are designed to maintain the health and resilience of forested ecosystems. This is important when factoring the effects of impacting activities.

Fire suppression has been the overriding strategy for dealing with all fires in the Project Area since settlement in the late 1800s. This strategy has caused a somewhat unnatural mix of vegetation in terms of structure and density. There are many more small-diameter trees and shrubs present today than there would be had fire played a role in the last 100 years. This limits the moisture and sunlight available for grasses and forbs to grow. Fire exclusion results in fewer, larger stems of Gambel oak, for example. The changes in vegetation cover resulting from fire suppression are important when evaluating the cumulative impacts of management prerogatives and projects on wildlife.

Somewhat offsetting fire suppressions effects are prescribed fires conducted in the HDs over the past 16 years that treated close to 10,500 acres. The primary effect to vegetation from these burns was to top-kill Gambel oak. No significant changes in tree canopy closure or density occurred because of these burns, and consequently there was impact to wildlife species from these projects.

3.1.5 Livestock Grazing

The BLM and NFS lands in the Project Area are generally available as rangeland for livestock under permitted grazing allotments. A grazing allotment is an area of land designated and managed for the grazing of livestock by one or more livestock operators. The number of livestock (stocking rate or carrying capacity) and period of use are stipulated for each allotment. The carrying capacity is an estimate of the maximum number of animals (expressed in Animal Unit Months [AUMs]) a given area can support each year without damage to vegetation or related resources. One AUM is the amount of forage necessary to support one animal-unit for one month. An animal-unit is a 1,000-pound cow typically consuming 780 pounds of air-dry forage for one month.

Grazing allotments are managed and multiple land uses are coordinated to maintain healthy public lands. The San Juan/San Miguel Planning Area RMP and amended RMP (BLM 1985, 1991), and the Decision Record for the Standards for Public Land Health and Guidelines for Livestock Grazing Management (BLM 1997) apply to development on BLM lands. The standards and guidelines for the NFS lands in the Project Area are provided in the SJNF LRMP and amended LRMP (FS 1983, 1992). These standards and guidelines are also discussed in the Vegetation section of this chapter.

The Project Area contains entire, or portions of, 7 BLM grazing allotments and 10 FS grazing allotments. Livestock grazing is permitted on 5 and 7 of the allot-

ments, respectively. On BLM lands, 300 AUMs are permitted for livestock grazing and on NFS Lands, 2,899 AUMs are permitted. Grazing is permitted on approximately 68 percent of public lands within the Project Area. Due to the steep, rugged terrain, livestock can graze only about 35 percent of NFS lands within the Project Area. BLM lands are generally more accessible within the Project Area. Range monitoring shows an upward trend in terms of species composition and cover to the benefit of wildlife.

3.1.6 Recreation

A broad spectrum of recreation occurs year-round in the Project and cumulative effects area. Summer activities include hiking, mountain biking, hunting, fishing, camping, sightseeing, all-terrain vehicle (ATV) riding, and wildlife viewing. Both BLM and SJNF are open seasonally to ATVs. CBM development's expansion of the road system, particularly on the SJNF, can attract additional motorized recreation use and could open up significantly more country. Areas easily accessible from Durango and Bayfield, such as Sauls Creek, are also expected to see increased day use for picnicking, hiking, mountain biking, and horseback riding because of increases in nearby populations. Increased human use of the project area over time can result in wildlife harassment and, in the extreme, habitat displacement. There is no indication that that is occurring now, but restriction of motorized human access to the project area should be considered as an option to mitigate these wildlife concerns in the future.

Recreational development is predicted to conflict with oil and gas development in the cumulative effects area during the project period. Most recreational development in the Four Corners is likely to occur in the towns themselves (e.g., Durango Recreation Center, Bayfield Recreation District) or in mountainous public lands (e.g., trails, trailhead facilities) where CBM development is now proposed. Some recreational facilities may be developed in association with residential subdivisions (e.g., bike paths), but such development could be coordinated with oil and gas facilities. The Animas-La Plata project will include a large recreation development (reservoir) but would be outside of the current oil and gas development area. No expansion of the Lake Navajo Recreation Area is foreseen.

Cumulative effects from other activities on private lands, such as ranching and agriculture, cannot be quantified because of a lack of formal study, but are discussed qualitatively in this chapter.

3.2 Existing CBM and Non-CBM Development

The alternatives discussed in Chapter 2 result in environmental consequences that are in addition to those resulting from existing CBM and non-CBM development within the Project Area. To understand the cumulative impacts of CBM and other land-impacting activities that act synergistically, an accounting of existing impacts is important. The following is a summary of the existing impacts of various CBM and non-CBM activities as of the end of 2002.

3.2.1 Wells

As of the end of 2002, approximately 290 CBM wells and 13 non-CBM wells (conventional oil or gas) had been completed in the Project Area. Construction of the pads for the CBM wells has resulted in a total short-term conversion of 406 acres and a long-term conversion of 290 acres to well pads. Construction of the pads for the non-CBM wells has resulted in a total short-term disturbance of 34 acres and a long-term disturbance of 21 acres. About 80 percent of the surface disturbance from CBM wells has occurred on private land. Of the 303 wells constructed in the Project Area, 25 wells are located on national forest, 29 are on BLM mineral estate, and 249 wells are on private or state mineral estate. The combined existing disturbance to public lands is 156 acres.

In addition to the CBM wells constructed through 2002, the agencies projected approximately 34 CBM wells constructed private and state mineral leases within the Project Area during 2003 to 2005. These wells are considered part of existing CBM development because these wells would be completed before the agencies release the ROD for this EIS. The agencies assume that construction of these 34 wells would result in short-term disturbance of 48 acres and long-term disturbances of 34 acres.

3.2.2 Produced-Water Disposal Wells

Five water disposal wells are in the Project Area and one is immediately outside it. Construction of these wells has resulted in 10 acres of short-term disturbance and 8 acres of long-term disturbance in the Project Area, and 2 acres of short-term disturbance and 1.6 acres of long-term disturbance outside it.

Water produced from existing CBM wells is handled differently in the western and eastern halves of the Project Area. In the western half, the companies transport the produced water via pipeline directly to one of six disposal wells. BP America disposes of produced water in three wells: the Los Piños Disposal Well (NE¼ of Section 31, T35N, R6W), the Wallace Gulch Disposal Well (SW¼ of Section 26, T35N, R7W), and the Bayfield Disposal well (SE¼ of Section 18, T34N, R6W). BP America also can route some produced water to other disposal wells south of the Project Area. J.M. Huber disposes of produced water in a disposal well at its DCS Central Facility. Pure Resource disposes of produced water at a disposal well in Section 36, T35N, R9W. In contrast to the western half of the Project Area, produced water from wells in the eastern portion of the Project Area is currently trucked to sites approved for disposal.

3.2.3 Compressor Stations

The companies use several compressor stations to compress CBM from wells for transport to delivery pipelines. These stations, which vary in size and number of compressors installed, are distributed across the Project Area in La Plata County.

There are four compressor stations in the Project Area; two are outside it. Construction of these stations has resulted in 12 acres of short- and long-term disturbance in the Project Area and 6 acres of short- and long-term disturbance just

outside it. Table 3-3 summarizes the details of the companies' compressor stations.

Table 3-3 Summary of the Companies' Existing Compressor Stations

Location	Name	Description	Total Horsepower
SW ¼ SE ¼ Section 36 T35N, R9W	State 36-2 Site	Two gas-fired units	2,220
NW ¼ NW ¼ Section 2 T34N, R9W	Crader Site	One gas-fired unit	1,100
NE ¼ NE ¼ Section 9, T34N, R8W	Durango Compressor Station (DCS) Facility	Six electric reciprocating units	5,500
NE ¼ Section 18 T34N, R6W	Bayfield Facility	Three electrically driven screw units	11,000
W ½ Section 15 T34N, R7W	Dry Creek[1]	Three lean-burn, gas-fired units	11,000
Section 3 UT33N, R5W	Pargin Mtn.[1]		1,100
Total			31,920

Note:
1. Slightly outside of the Project Area
Sources: Bell 2001 and Brown 2001

3.2.4 Access Roads and Gas- and Produced Water-Gathering Pipelines

For this analysis, the agencies assume that the access roads and gas- and produced-water-gathering pipelines would be constructed together within the same corridor. Additionally, we assume that the long-term disturbance for the corridor for the access road and gathering pipelines is 25 feet wide and that the average length of the corridor for each access road and gathering pipeline is 1,074 feet, or 0.2 mile (Bell 2001). Consequently, the existing long-term disturbance associated with each access road and gathering pipeline is 0.6 acres, and the total long-term disturbance for all 289 CBM and non-CBM wells is 175 acres. The roads for the 34 CBM wells constructed in 2002 created almost 21 acres of long-term disturbance, but these roads are not identified on the EIS maps for this analysis.

3.2.5 Summary of Existing Development

Existing development is summarized in Table 3-4; disturbances are incorporated into the cumulative effects.

Table 3-4 Summary of Existing Oil and Gas Development

Facility	Number of Units	Amount of Long-term Disturbance (acres)
Project Area – Mapped Development		
CBM Wells	290	290
Non-CBM Wells	13	21
Disposal Wells	5	8
Compressor Stations	4	12
Roads (miles)	58	173
Total	370	504
Disposal Wells	1	2
Compressor Stations	2	6
Roads (miles)	7	20
Total	10	1036
Total	380	566
Forest Service – Mapped Development		
CBM Wells	25	25
Non-CBM Wells	0	0
Disposal Wells	0	0
Compressor Stations	0	0
Roads (miles)	10	48
Total	35	73
Disposal Wells	0	0
Compressor Stations	0	0
Roads (miles)	0	0
Total	0	0
Total	35	73
BLM – Mapped Development		
CBM Wells	29	29
Non-CBM Wells	0	0
Disposal Wells	1	2
Compressor Stations	0	0
Roads (miles)	11	54
Total	41	83
Disposal Wells	0	0
Compressor Stations	0	0
Roads (miles)	0	0
Total	0	0
Total	41	83

3.3 Migration and Seepage of Methane

3.3.1 Issues

This section discusses the affected environment and probable environmental effects of CBM development on methane migration and seepage. The following issues were identified during the scoping process for this EIS.

Issue 1: The effects of additional CBM development on the Fruitland Formation outcrop and on groundwater aquifers and wells, with respect to methane seepage and contamination.

The following are specific facets of this issue:

- The effects of CBM-development and methane seepage-related impacts on surface water.
- Dewatering the Fruitland Formation may trigger the release of methane and hydrogen sulfide, especially near the outcrop.
- The effects at the outcrop of continued or accelerated dewatering of the Fruitland Formation and Pictured Cliffs Sandstone.
- Intensified drilling may affect shallow aquifers.
- The effects of CBM-related methane seepage affect human health and safety.
- The effects of increased CBM development and methane seepage on vegetation.
- The effects of methane seepage on soils in the Project Area.

3.3.2 Introduction

CBM development on each land jurisdiction in the Project Area is thought to contribute synergistically to methane seepage, and because of intermingled mineral estate ownership patterns (federal, state and private), the source of methane seepage cannot be attributed to a single source or jurisdiction. For that reason, in the western Project Area, CBM development on all jurisdictions is treated as a comprehensive causative factor from the standpoint of describing probable environmental consequences. In the eastern Project Area, in contrast, most new CBM development would occur on national forest (approximately 173 federal wells, 14 private wells and two state wells) consequently, the cause of methane seeps in the eastern Project Area, if they were to occur, would be predominantly federal well development, and less so private and state well development. See for example, the distribution of existing and proposed CBM wells, by jurisdiction, in Figure 2–2, Chapter 2).

Within the Project Area's west side, the area of Fruitland Formation outcrop that may be affected by methane seepage is primarily private surface. The eastern Fruitland outcrop is located mostly on national forest. In the discussions that follow distinctions are made between the western and eastern Project Areas to help describe the jurisdictions (federal, private, state wells) that may cause methane seepage, and the land ownerships that may be affected by methane seepage.

Methane seepage can be divided into two areas of concern:

- The interior of the basin, and,
- The Fruitland Outcrop.

The two regions are shown on Figure 3–1.

3.3.3 Methane Seepage in the Basin Interior

Domestic water wells in the interior of the San Juan Basin have been affected by methane seepage, as documented in BLM reports and studies dating back to 1991 (BLM 2000a). This methane seepage is associated with older conventional gas wells (dating from the 1950s and 1960s) that were not cemented to the ground surface when they were installed, creating a conduit for migration of methane from the Fruitland Formation upward to the shallow aquifers (Figure 3–2).

The BLM and COGCC require operators to monitor the pressures in the surface or intermediate casing (Bradenhead pressures) annually in each gas well. This program was developed to identify potential problem wells that may be acting as conduits for methane from the reservoir formations into the shallow aquifers. Should excessive pressures be detected, the operators are required to repair the well. Repairs consist of forcing cement between the well casing and in the rock formations between the Fruitland Formation and the shallow aquifers to create a seal. This seal prevents the upward flow of methane. In addition, the COGCC and BLM now require that the gas well casing (surface and production casing) be cemented from bottom to top. A COGCC study (Garody et al. 2004) determined that there was no discernible change in methane concentrations in 1034 sampled water wells in La Plata County since the BLM and COGCC issued their 160-acre infill orders and the associated water well sampling requirements in early 2000.

Annual Bradenhead pressure measurements are recorded so that remedial actions can be taken on these older wells as soon as a potential problem is identified. Rapid response should prevent any potential contamination by methane in the shallow aquifers from spreading to nearby domestic water wells.

There are other potential sources of methane in shallow aquifers that are not associated with CBM development. These include biogenic methane and microseepage from deep formations over geologic time scales. Biogenic methane is generated by bacteria called methanogens, which are present in many subsurface settings. Microseepage is simply slow methane migration (low flux) upward from hydrocarbon reservoirs and source rocks. The low flux of methane is measurable over many known gas reservoirs and, although it has not been documented, microseepage may occur within the Project Area as a natural phenomenon. The combination of these natural factors explains why methane commonly occurs at very low concentrations in domestic water wells throughout the Project Area.

Hydrofracturing and cavitation do not create pathways for migration of methane from the coal beds in the Fruitland Formation to the shallow aquifers. Fracture-stimulation effects extend up to 600 feet laterally from a well bore, and vertical propagation of fractures is typically confined to the coal beds (Diamond 1987). More than 2,000 feet of strata intervenes between the Fruitland coal beds and the shallow domestic aquifers in the interior of the basin. As a result, fractures will

not propagate from coal beds to the shallow aquifers, even under the most extreme fracturing pressures used in CBM development. Effects from cavitation are even more limited in the subsurface, typically affecting only the coal beds to a lateral distance of less than 100 feet (EPA 2002a).

In summary, there have been no documented cases where CBM development (either well drilling, fracing, or operations) could be linked directly to methane in shallow aquifers. There are, however, two natural phenomena that more likely explain the occurrence of methane in shallow aquifers. These are biogenic-sourced methane from bacteria, and microseepage that occurs naturally over geologic time.

Because there is no plausible evidence that CBM development would impact shallow aquifers in the basin interior through methane seepage, this issue will not be carried forward in the remaining analyses of environmental impacts.

3.3.4 Methane Seepage at the Fruitland Outcrop

Specific concerns related to methane seepage at the Fruitland Formation Outcrop include:

- Increase in dead trees and plants,
- Risk to human health and safety,
- Loss of natural gas resource,
- Reduction of wildlife habitat, and
- Contamination of domestic water wells tapped into the Fruitland Formation.

Though it was reported historically, methane seepage has accelerated at locations along the Outcrop (Figure 3–1 and Figure 3–3). Naturally occurring gas seeps have been observed from Menefee coals west of Durango, in the Lewis Shale in Ridges Basin, and in the Lewis Shale at Yellowjacket Pass in Archuleta County. None of these seeps is reported to be increasing in rate or areal extent. Only the methane seeps on the Fruitland outcrop appear to be affected by gas development in the SJB, based on the current body of evidence.

Since the late 1800s, methane seeps have been observed and reported in the Fruitland Formation outcrop. The number of reports and complaints of methane seeps received by public officials increased from the mid-1980s into the 2000s (BLM et al. 2002). This increase coincided with intensified development of CBM in the coal beds of the Fruitland Formation and a concurrent increase in population in the Project Area. Data suggest that the intensity and areal extent of known seeps increased and that new seeps developed after CBM development began (BLM et al. 2002). Consequently, it appears CBM that CBM development has caused new seeps and expanded existing seeps. CBM wells are thought to contribute to the lowering of the water table along the Formation outcrop which is postulated to allow CBM to desorb from the coal beds near the outcrop. The desorbed gas can then migrate buoyantly updip to the outcrop and then seep. Other phenomena, such as drought may also contribute to a lowering of the water table, causing seepage to be diffused in the overlying rock and soil.

3.3.4.1 Methane (CH_4) - Background

Methane is a gas that is created naturally from decomposition of organic compounds, including coal. Methane is a nontoxic, nonpoisonous gas that does not cause cancer. Its presence can pose a risk to human health and safety, however (such as hazards from explosion and confined-space entry), and seepage at the ground surface can adversely affect other natural resources, including vegetation and wildlife.

Methane is highly flammable and explosive under certain conditions. Methane that seeps into confined spaces that are poorly ventilated or unventilated (basements or water wells, for example) and are exposed to a source of heat can explode or burn. The buildup of methane in inadequately ventilated, confined spaces that people may occupy poses a risk of suffocation (methane displaces oxygen, creating an oxygen-deficient atmosphere in a confined space).

In addition to being flammable and explosive, methane displaces oxygen from pore spaces within soils. This displacement deprives plant roots of the oxygen they need for respiration, ultimately killing the plant. The presence of dead vegetation around gas seeps in pastures and stands of stressed and dying trees on the coal beds are indications of active methane seeps.

3.3.4.2 Hydrogen Sulfide — Background

Hydrogen sulfide is also associated with some of the methane seeps. The methane can create an anaerobic environment where sulfate-reducing bacteria proliferate. These bacteria release hydrogen sulfide, a colorless, foul-smelling, toxic gas. This gas can damage vegetation by impairing the plant's respiratory function. In addition, hydrogen sulfide is harmful to the health of wildlife and humans when it is present in sufficient quantities.

In the Project Area, hydrogen sulfide occurs near the Carbon Junction methane seeps in the Animas River Valley and at one known site along Texas Creek, on CR 502.

Hydrogen sulfide has been reported since the late 1800s at the Animas River Valley seep; therefore, it is not associated with CBM development. The hydrogen sulfide at Texas Creek may or may not be associated with CBM development. The true timing and cause of the hydrogen sulfide at Texas Creek is unknown. However, a decrease in the water table in the outcrop coal beds in this area has been documented by groundwater level measurements conducted by BLM personnel. This drop in the water table and the increase in methane seepage may have created the conditions for sulfate-reducing bacteria to bloom. Conversely, these bacteria may have been present historically, and the hydrogen sulfide was encountered only after a domestic well was drilled through this bacteria-filled zone.

BLM's outcrop monitoring indicates that concentrations of hydrogen sulfide in the Project Area are not increasing. Monitoring will continue because of the public-safety issues associated with hydrogen sulfide, and because marked increases have been observed along the outcrop of the Fruitland Formation southwest of the Project Area.

On the Southern Ute Indian Reservation south of the Project Area, numerous soil vapor monitoring tubes show increasing concentrations of hydrogen sulfide. The data presents evidence that the increasing trends are associated with CBM development. In light of the increases of hydrogen sulfide observed along the outcrop of the Fruitland Formation near the Project Area, it is considered that seeps of hydrogen sulfide may increase in the Project Area as well. Although the mechanisms for generation of hydrogen sulfide are understood, the extent and rate of the seeps cannot be quantified.

3.3.5 Current Conditions—Methane Seepage

As discussed above, methane migrates and seeps naturally and because of human activities in the Project Area. Known, naturally occurring methane seeps include Carbon Junction where the Animas River crosses the Fruitland Formation, the Pine River/Texas Creek/Florida River area, and Ridges Basin (Figure 3–3). Other seeps that are not associated with the Fruitland Formation have also been observed in La Plata and Archuleta Counties. Specifically, BLM personnel have observed seeps in the Menefee Formation near Ridges Basin in La Plata County and in the Lewis Shale near Yellowjacket Pass, off Highway 160 in Archuleta County. The Bureau of Reclamation (BOR) also identified and mapped gas seeps from the Lewis Shale in the Ridges Basin area.

The BLM has monitored methane seepage along the outcrop of the Fruitland Formation six times per year (every other month) since 1995 at several locations (Figure 3–4). Additional methane seepage monitoring has been conducted by LT Environmental, Inc. (LTE) on behalf of the COGCC, the BLM, La Plata County and three gas operating companies since 1997. LTE and BLM analysis of the monitoring data through 2004 indicate that concentrations of methane are increasing in the shallow soils that immediately overlie the coal beds of the Fruitland Formation in some areas, and decreasing in other areas. The results also indicate that not all the coal beds seep methane, and that no active seeps have been identified over the strata in the Fruitland Formation that are not composed of coal (such as sandstones and mudstones). Field monitoring of seeps also indicates that the intensity of the seep may be decreasing in some areas, yet the net overall area affected by methane seepage is increasing.

The most recent statistical analysis of 180 soil vapor probes was conducted in 2004, based on measurements collected between 1997 and 2004. Of 180 probes, 81 probes had measurable trends and 99 probes rarely reported detectable methane, if ever. Of the 81 probes with measurable trends, 32 probes exhibited a measurable trend at the 95 percent confidence interval. Upward trends at the 95% confidence interval were noted in 21 probes, and 11 probes exhibited downward trends at the 95 percent confidence interval (LTE 2004).

A network of gas flux chambers are also monitored continuously. Gas flux monitors have shown sporadic flow but no discernable increasing or decreasing trend in gas seepage has been noted (LTE 2004).

In 1999, the BLM, SUIT, and COGCC contracted with Questa Engineering (Questa), Applied Hydrology Associates (AHA), and the Colorado Geological Survey (CGS) to conduct the 3M (Modeling, Monitoring, and Mapping) Study.

The 3M CBM Model, developed out of this collaboration, is based on up to 16 years of production data from 1,060 wells, 4,870 pressure measurements from 591 wells, coal thickness data from 742 wells, and water chemistry data from 572 wells. The Model divided the Colorado portion of the San Juan Basin into six modeling domains, two of which comprise a significant portion of the Project Area.

The first modeling domain of interest, Area B in the 3M Model, includes portions of the Fruitland Formation outcrop from the Animas River valley to near the South Fork of Texas Creek. This area contains many of the high volume water producing wells in the Basin. Although gas seepage has been reported in the Animas River valley for many years it was arguable whether there was a significant increase in seepage in Area B through 1999. The 3M Model runs indicate that seepage in Area B should be expected to increase for several years once significant incremental seepage is observed. The projected peak seep rate is about 1 to 1.5 million cubic feet per day (MMcfd) and would be reached around 2017 to 2020 as a result of current CBM development. Infill wells would be expected to reduce seepage in Area B substantially after 2015 (Questa 2000).

The second modeling domain, Area C in the 3M Model, includes portions of the Fruitland outcrop from the South Fork of Texas Creek to the Piedra River. The Pine River seep area is contained in Area C. Area C contains many high productivity wells, including high rate water producers and high rate gas producers. Seepage in the Pine River area was reported around 1993, and it has been one of the most conspicuous gas seep areas since that time. Seepage was reported around the South Fork of Texas Creek not long after it was observed in the Pine River Area. The 3M Model simulation runs indicate that without additional infill drilling, seepage in Area C should be expected to increase perhaps 10 percent over current levels through 2011, and then begin to decline. If infill wells are drilled in Area C, the projected seepage rate may increase to 25 percent higher than current levels by 2010. Overall infill wells are expected to have little impact on seepage in Area C (Questa 2000). The proposed La Plata County wells evaluated in this EIS are all infill wells.

Across the entire modeling domain, the modeling by Applied Hydrology Associates and Questa concluded that methane seepage at the outcrop of the Fruitland Formation has increased since CBM development began (Figure 3–5 and Figure 3–6). The 3M Model predicted that the intensity of the seep, or methane flux, would decline in some areas of pre-existing seeps, but that the overall area affected by methane seepage would increase (Figure 3–7 and Figure 3–8). This conclusion is supported by BLM and LTE studies published to date, which show generally increasing areas and methane concentrations for many of the known methane seeps along the Fruitland outcrop.

Overall, the 3M Model projects seepage by the year 2000 within the Colorado portion of the SJB at about 5 MMcfd. The 3M Model predicts that seepage will peak at 10 MMcfd, or about twice the current level, around the year 2009 (Questa 2000). The 3M Model also predicts that the infill wells will have a mitigating effect on gas seepage. Cumulative seepage through the year 2030 is projected to be 11 percent lower with infill wells than without infill wells and cumulative seepage through the year 2200 is projected to be 21 percent lower with infill

wells than without infill wells. The infill wells, in other words, will capture part of the gas that would otherwise migrate updip and escape at the outcrop (Questa 2000). Since all of the projected wells in La Plata County are infill wells, the five alternatives would not contribute to increased methane seepage in La Plata County. Furthermore, seep occurrence and rates do not appear to be sensitive to the timing of and well spacing for wells drilled within 1.5 miles of the outcrop of the Fruitland Formation (Questa 2002).

In contrast to La Plata County, there has been very limited development in Archuleta County to date. The descriptions of potential outcrop effects in the eastern Project Area are therefore based on limited information regarding Fruitland coal characteristics and on the different CBM development strategies represented by the alternatives. The differences between alternatives in the eastern Project Area are described in Section 3.3.6. If CBM development of the eastern Project Area followed the same pattern of development and resultant effects as La Plata County, then widespread development may trigger methane seepage at the outcrop in Archuleta County.

Seep locations are shown graphically in Figure 3–7 which is a bubble map of projected seepage in 2000. Larger bubbles indicate more active seeps, which the 3M Model predicts, and monitoring has shown, to be located in the Pine River area and around Valencia Canyon gap. Figure 3–8 shows computed seepage in 2030. A comparison between the two figures indicates that additional seeps may occur between Indian Creek and the Animas River drainage on the west (outside the Project Area), from the Pine River to the South Fork of Texas Creek, and from the Pine River east towards Beaver Creek. The emergence of active seepage may also occur in Archuleta County, where there has been limited development to date as a result of the alternatives (Questa 2002). A baseline survey conducted along the Fruitland outcrop in Archuleta County in 2005 did not identify any areas that appeared to contain active methane seeps (LTE 2005).

There is not a continuous belt of dead vegetation along the outcrop of the Fruitland Formation (Figure 3–7).Methane seeps along the outcrop are best described as spotty. Intense seeps, where vegetation dies off, usually occur in areas of less than ¼ acre, but intense seeps that cover several acres have been documented in several locations, such as Carbon Junction.

Lower-intensity seeps along the outcrop do not cause vegetation die-offs. The rate of methane seepage at these locations is too low to displace air in the overlying soils to the point where plant roots are deprived of adequate oxygen. The BLM's monitoring program has identified these types of seeps at areas east of the Pine River, Edgemont Ranch, Ridges Basin, and Texas Creek (Figure 3–4). Low-intensity seeps also occur randomly along the outcrop and appear to occur only where a coal bed immediately underlies the seep area. In comparing the detailed mapping data from 2002 to 2004, LTE noted both increases and decreases in subsurface methane concentrations and extent of methane gas seeps. However, the general comparisons across the Project Area (La Plata County) appear to show increases in methane concentration and/or seep extent more frequently than decreases.

There are up to 40 domestic wells that draw water from the Fruitland Formation and Pictured Cliffs Sandstone along the outcrop belt in the Project Area (Figure 3–9). These wells are open to the coal beds and sandstones, and several are known to contain methane concentrations at saturated levels (13 milligrams per liter [mg/L]). The vigorous bubbling of methane can be heard at the wellhead in one domestic well along Texas Creek. The water treatment system vents to the atmosphere, however, and poses no risks to human health and safety. These water wells could be affected by methane gas in two ways. First, CBM development contributes to gas desorption which may migrate up the well bore of a domestic well. Secondly, the water wells themselves act as de facto CBM wells by drawing water out of the coals. Methane is held in the coals by hydrostatic pressure. The domestic wells pumping of water is thus also a means by which methane can be liberated.

Currently, it is estimated that approximately 130 acres along the outcrop of the Fruitland Formation have detectable methane seepage areas. This estimate is based on field surveys of the outcrop area performed by LTE. A semi-quantitative approach was used to estimate the maximum potentially affected area. Using an average outcrop width (¼ mile) times the length (40 miles) yields the total surface area of the outcrop of the Fruitland Formation in the Project Area. Coal beds make up about 20 percent of the Fruitland Formation, and methane seeps are confined to coal beds. Roughly 50 percent of the coal beds are seeping methane at several BLM monitoring transects with active seeps. The total potentially affected area is calculated as width (¼ mile) times length (40 miles) times 0.20 (20 percent) times 0.50 (50 percent). Therefore, an upper limit of the total affected surface area can be calculated. This method yields 640 acres as a potential maximum impact in the Project Area. This estimate does not imply that 640 acres have been affected, however. Rather, it is a rough estimate of the maximum area that may ultimately be affected by CBM development if the 3M Model projections were realized. In reality, the area of methane seepage will probably be less than this due to geologic and hydrologic factors. Outcrop monitoring is necessary to determine the accuracy of the 3M Model, and will form the basis for area-specific assessments and appropriate mitigative actions if necessary.

Rivers and creeks that flow across the Fruitland Formation also exhibit active methane seeps. Active seeps appear in Texas Creek, the Animas River, the Florida River, and the Pine River where they cross the Fruitland Formation. These seeps were reported before any CBM development began, and modeling results indicate they will not increase in rate. Methane entrained in surface water volatilizes quickly into the atmosphere, where ultraviolet radiation ultimately breaks down its molecules. In fact, methane concentrations are too low to be measured within several hundred meters downstream of the active seep areas. Based on current data, it appears that methane seepage into surface water has no measurable effect on water quality or aquatic life.

3.3.6 Affected Resources and Environmental Consequences — Methane Seepage

3.3.6.1 Background on Current Studies

The following assessment of the groundwater system, methane seeps, and impacts related to CBM development is based on BLM and FS interpretation of field data, published papers, and projections made by the 3M Model (Questa 2000) and the work of Cox and others (2001).

Additional research of the hydrocarbon system of the Fruitland Formation, presented as public comment, is also discussed in this final EIS. Specifically, Riese and others (2005) present a somewhat diverging hypothesis of the operation of the groundwater system and the impacts of CBM development. Riese and others' assessment is based on essentially the same data sets available to the BLM/FS and utilized by Questa and Cox and others.

BLM and FS, after careful consideration, determined that the results of the 3M Model and Cox and others are based on a more reliable and reasonable interpretation of the best available scientific information than the results of Riese and others. The factors that BLM and FS considered in making this determination are described in the following paragraphs of this section.

The principal difference between the BLM/FS position and that of Riese and others arises from different interpretations of the basic nature, character, and operation of the Fruitland Formation aquifer system:

- BLM and FS describe the Fruitland Formation aquifer system as composed of interbedded, lenticular coals and sandstones with lesser amounts of mudstone and shale. These interbedded, lenticular units make up an interconnected aquifer system, with highly variable flow characteristics, that conducts groundwater from the recharge areas at the outcrop to discharge areas at local rivers and streams and to deeper, long term groundwater flow paths into the deeper portions of the SJB that eventually discharge at the San Juan River and Rio Puerco in New Mexico. The aquifer, including the Pictured Cliffs Sandstone, is confined by the overlying Kirtland Shale and underlying and Lewis Shale, and the confined nature of the unit begins a few hundred yards down dip from the Fruitland Formation outcrop.
- According to Riese and others, the Fruitland Formation aquifer system is also composed of interbedded, lenticular coals and sandstones with lesser amounts of mudstone and shale. These interbedded lenticular units, however, are not interconnected, do not form a continuous aquifer, and do not conduct groundwater from the recharge areas at the outcrop to deeper flow paths into the SJB, including areas of present CBM development relatively near the outcrop. Thereby, the areas of CBM development and groundwater withdrawals are completely isolated from the outcrop and have no connection to present recharge or groundwater levels near the outcrop.

These two fundamentally different hypotheses regarding the characteristics of the Fruitland Formation coal beds lead to different conclusions about the overall effects of groundwater withdrawals associated with CBM development. Table 3-5 presents these differences.

Table 3-5 Comparison of Conclusions Regarding Impacts of CBM Development

Impact Issue	BLM/FS	Riese and others (2005)
Methane Seeps and Vegetation Impacts and Die-Off	CBM related groundwater withdrawals from the Fruitland Formation allows gas desorption from the Fruitland coals which, in turn, causes changes and increases in methane seeps at the outcrop as well as increased areal extent of vegetation impacts and die-offs.	CBM related groundwater withdrawals from the Fruitland Formation have no effect on methane seeps. Vegetation impacts and die-offs are caused by drought and other factors unrelated to CBM development.
Groundwater level declines near the outcrop	CBM related groundwater withdrawals from the Fruitland Formation can cause declines in groundwater levels near the outcrop.	CBM related groundwater withdrawals from the Fruitland Formation have no effect on groundwater levels near the outcrop.
Declines in natural spring flow from springs issuing from Fruitland Formation outcrop	CBM related groundwater withdrawals from the Fruitland Formation may cause declines in natural spring flow or drying up of springs.	CBM related groundwater withdrawals from the Fruitland Formation do not affect natural springs
Reduction in groundwater discharge from the Fruitland Formation to area rivers and streams.	CBM related groundwater withdrawals from the Fruitland Formation will intercept groundwater that would normally discharge to area rivers and streams and will decrease baseflow to those rivers.	CBM related groundwater withdrawals from the Fruitland Formation have no effect on groundwater discharge to area rivers and will have no effect on baseflow in the rivers.

Specifically, the BLM/FS have chosen to use the work of the 3M Model (Questa 2000) and of Cox et al. (2001) to structure the analysis of environmental consequences for the following reasons:

- The conclusions of the 3M Model (Questa 2000) and Cox et al. (2001) are based on a large, representative data set taken from over one thousand gas production wells in the NSJB.
- The conclusions of the 3M Model (Questa 2000) and Cox et al. (2001) are based on widely accepted scientific assumptions about the way groundwater flows through a heterogeneous aquifer system as represented by the Fruitland Formation and Pictured Cliffs sandstone.
- The conclusions of the 3M Model (Questa 2000) and Cox et al. (2001) are based on groundwater modeling techniques and assumptions that are commonly used to represent complex groundwater flow systems and groundwater/surface-water interaction.

- A large body of peer-reviewed published literature supports the BLM and FS' conclusion that the Fruitland Formation is a regional confined aquifer system with interconnected coal beds capable of actively transporting groundwater, as described in FEIS Sections 3.5.2 and 3.5.3, Hydrogeology of the Fruitland Formation and Other Supporting Information.
- The conclusions of the 3M Model (Questa 2000) and Cox et al. (2001) are generally supported by anecdotal observations and twelve years of field data collected by State, Local, and Federal agencies along the outcrop (BLM 2000a, BLM Soil Vapor Tube Studies, 1997–2006, Various BLM and COGCC Studies 1994–2006). This is particularly true in the western portion of the study area and in river and stream valleys in La Plata County.

The BLM and FS do not believe that Riese and others (2005) present a supportable model of groundwater flow characteristics in the Fruitland Formation aquifer along the NSJB or of the interaction of groundwater and surface water in the area for the following reasons:

- The conclusions of Riese et al. (2005) are based on a very limited data set (water samples from one hundred gas production wells and seven core samples). In contrast, the 3M study relied on data from over one thousand gas production wells, as noted above.
- The conclusions of Riese et al. (2005) are not consistent with the observations of methane seepage behavior at the outcrop as described by 12 years of monitoring data collected by the BLM and the COGCC.
- The conclusions of Riese et al. (2005) are based on the unsupported concept that the Fruitland Formation coals cannot be a through-flowing system and there is no hydraulic connection between the groundwater recharge area at the Fruitland Formation outcrop and the down-dip production area. As noted above, a large body of peer-reviewed published literature supports the BLM and FS' conclusion that the Fruitland Formation is a regional confined aquifer system with interconnected coal beds capable of actively transporting groundwater, as described in FEIS Sections 3.5.2 and 3.5.3, Hydrogeology of the Fruitland Formation and Other Supporting Information.
- The conclusions of Riese et al. (2005) are not consistent with USGS review. Regarding the concept of Riese et al. of complete hydraulic separation between the outcrop and production areas, Watts (2006:1) says, "Combined thickness of the coals can be as much as 120 feet in a 200-foot interval (Riese et al. 2005:76) and although the coal aquifer is heterogeneous and anisotropic that does not mean it is impermeable or that fluid pressure does not form a continuum from deeper parts of the basin to the outcrop. Water flows may be discontinuous, if cleat porosity is gas filled, because water permeability is a function of water saturation. However, as gas is depleted from the coal during production, water saturation and water permeability will eventually increase. The reduction in fluid (gas or water) pressure caused by gas and water production would be transmitted through the reservoir/coal aquifer and, thus, can affect

groundwater levels and flow in the coal aquifer at outcrop and subcrop areas."

- The groundwater flow patterns described by Riese et al. (2005) are not typical and their existence would require unique geologic and hydrologic features that have not been identified in the NSJB.

For these reasons, the BLM and FS believe that the results of the 3M Model and Cox and others are based on a more reliable and reasonable interpretation of the best available scientific information than the results of Riese et al. Therefore, the development of the groundwater, surface water and methane seepage impact analyses and conclusions presented in EIS Sections 3.3, 3.5, and 3.6 are based on the 3M Model and the work of Cox et al.

There are areas of agreement between the BLM and FS' position and that of Riese and others. BLM and FS agree that drought and other natural factors play a role in vegetation impacts and methane seepage. Another area of agreement is that the composition and physical characteristics (like cleating) of the Fruitland coals affect permeability and hydraulic conductivity, which are important factors influencing water flow and methane seepage. Geologic and tectonic influences including faulting, folding, jointing, fracturing, uplift, and subsidence are also important, non-disputed factors.

The differing conclusions that apply to methane seeps and groundwater and surface water impacts highlight that there are areas of uncertainty and conflicting research that would benefit from additional monitoring data to validate and/or improve the conclusions. Neither interpretation of the Fruitland hydrological regimes can be considered fully conclusive at this time. Additional monitoring and research is warranted to better determine relationships between CBM development and methane seepage, while focusing on mitigative efforts to protect human health and safety and minimize environmental impacts.

3.3.6.2 Groundwater

Groundwater resources in certain areas along the Fruitland outcrop are affected by CBM development, based on BLM studies in the Valencia Canyon, Texas Creek and Pine River areas and COGCC monitoring well data in La Plata County. Through extrapolation of the results of the 3M Model and Cox and others, similar impacts are predicted to occur along most of the Fruitland outcrop and to continue beyond the life of the project, although specific locations and amounts are dependent on geologic and hydrologic factors. With CBM development expanding eastward into Archuleta County, groundwater resources along the outcrop of the Fruitland Formation in Archuleta County may also be affected by increased methane seepage. Monitoring efforts are ongoing to collect baseline information in Archuleta County so that potential CBM-related groundwater impacts can be measured and mitigated, if necessary.

Two types of groundwater impacts are of concern: methane contamination of domestic water wells and the loss of groundwater due to the lowering of water levels in wells. Other factors such as drought and the dewatering effect of the domestic wells themselves may act synergistically with CBM development to trigger groundwater impacts. Methane contamination is addressed here and loss

of groundwater due to lowering of the water table is addressed in the groundwater section of this chapter

We have divided the Project Area into a western and eastern area for the purpose of evaluating and describing environmental consequences. The western Project Area has been extensively developed, monitored and analyzed, and Fruitland outcrop impacts are thought to be a result of existing development and relatively insensitive to additional infill CBM development The eastern Project Area (primarily national forest), on the other hand, has not been extensively developed, although baseline Fruitland Formation outcrop monitoring has been established. In the eastern Project Area, Fruitland outcrop impacts could be triggered by new CBM development.

3.3.6.2.1 Alternative 1 — Proposed Action

In the western Project Area (La Plata County) between the Animas River and Beaver Creek, there has been an increase in methane seepage as a result of existing CBM development. This seepage is expected to peak around 2014 and then to begin slowly declining. Infill wells drilled in the western Project Area are predicted to have a slight mitigating effect, reducing the timeframe at which methane seeps will peak, and reducing the amount of methane seepage from levels predicted without infill CBM development (Questa 2000).

The 3M Model predicts that gas seepage has occurred and will continue to occur at the current seeps in the western Project Area. The 3M Model also predicts increases in the areal extent of methane seeps, regardless of the additional development represented by the alternatives (Figure 3–8). As a consequence, the number of shallow domestic wells, seeps, and springs that may be affected by methane seepage may also increase. According to the state water engineer's database, 39 domestic water wells are situated on the outcrop of the Fruitland Formation in the Project Area (Figure 3–9). Any number of these wells may be affected with increased concentrations of methane as a result of CBM development. Drought and the gas desorbing effects of the domestic wells themselves, may also contribute to groundwater impacts, both in terms of quantity and quality of water produced from domestic wells. The modeling of methane seepage, however, cannot quantify these potential groundwater impacts, they are instead presented as a potential cause and effect relationship which, given a worst case scenario, would result in eventual contamination or dewatering of all 39 domestic wells tapped into the Fruitland Formation.

Baseline monitoring in the eastern Project Area has established that there have been no detected methane seeps to date along the Fruitland outcrop between Beaver Creek to the west and the Piedra River in Archuleta County, a band of approximately 18 miles (LTE 2005). Future CBM development of this relatively undeveloped area may trigger increased methane seepage or groundwater impacts, as has been experienced in the western Project Area. Within this eastern area, development within close proximity of the Fruitland outcrop would take place within the Fosset Gulch Federal Unit under Alternative 1, at a distance of ¾ mile to 1½ miles of the Fruitland outcrop. We anticipate that these near outcrop gas wells would have a greater potential to trigger methane seepage and groundwater impacts than wells drilled more distant from the outcrop. These groundwater impacts and methane seepage in turn, could de-water and/or con-

taminate the domestic water wells proximal to the Fruitland outcrop in the eastern Project Area. To detect methane and to mitigate contamination and dewatering effects if realized, all domestic water wells in the eastern Project Area would be monitored prior to CBM development and annually as described in Section 3.3.10.

The description of methane seep impacts in the eastern Project Area is presented with qualification. There are apparent differences in coal and hydrological characteristic between the western and eastern Project Area that may affect the extent of methane seepage (Mansoori 2005). First, CBM wells drilled into the coals in the area of the Fosset Gulch Unit in the eastern Project Area are predicted to produce little water, in the order of 5 to 25 barrels per day, as opposed to the high water production rates realized in western Project Area wells. This dry coal condition suggests that there may be limited hydrological reduction in head to the Fruitland outcrop from wells drilled at some 1000's of feet from the outcrop. With limited hydrological connection, methane gas may not be desorbed in large quantities along the nearby Fruitland outcrop as a result of CBM development, nor may water levels of domestic water wells be measurably drawn down.

Second, the coal cleating (fracture) patterns and their orientation to the outcrop are also different within the east side, Fosset Gulch Unit than the Project Area's west side (Laubach et al. 1998) Coal cleats provide the principal conduit for coal bed methane gas flow, and their orientation is an important characteristic in determining well drainage pattern and drainage orientation. In the eastern Project Area, the fracture system runs in a southeast — northwest orientation, parallel to the Fruitland outcrop. This orientation is in contrast to the western Project Area where the Fruitland outcrop is perpendicular to the coal fracture system and the orientation of well drainage is toward the outcrop. With this parallel cleat orientation, the zone of influence of a CBM well drilled within the Fosset Gulch Unit may be of the order of roughly one mile or less perpendicular to the axis of the coal fracture system. Wells drilled outside of this zone may not measurably impact the Fruitland outcrop.

Given these apparently different coal characteristics, there may be a lower potential for CBM production to trigger methane seeps in the Fosset Gulch Unit than has been realized in the western Project Area.

3.3.6.2.2 Alternative 2

The results of the 3M study indicate that methane seepage at the outcrop is relatively insensitive to 320-acre well spacing versus 160-acre spacing, timing of development near the outcrop, or other factors. In other words, existing CBM development in the western Project Area has triggered increased methane seepage while added CBM development would not contribute to further increase seepage (Figure 3–5). Conversely, the 3M CBM Model projects that long-term seepage would be less as a result of infill drilling as in Alternative 2, because the infill wells will capture part of the gas that would otherwise migrate updip and escape out of the Fruitland outcrop as seepage.

However, despite the mitigating effect of infill wells on methane seepage, the areal extent of methane seepage is still projected to increase in the western Project Area. With the projected increase in areal extent of methane seepage, the

number of shallow water wells affected by methane seepage would increase. Up to 39 shallow water wells may be affected by increased methane seepage.

Methane seep impacts in the eastern Project Area would also be as described in Alternative 1 but the potential for Alternative 2 triggering methane seeps would be higher due to the greater number of CBM wells developed within close proximity of the Fruitland outcrop, particularly in the Beaver Creek, Lange Canyon, and Squaw Creek areas. The 3M Model predicts that eastern Project Area CBM development at 320-acre or 160-acre spacing would trigger methane seepage at the Fruitland outcrop. This, in turn, could affect domestic wells in the eastern outcrop area. All domestic wells would be monitored prior to CBM development and annually as described in Section 3.3.10 to detect methane and to mitigate contamination effects if realized.

3.3.6.2.3 Alternative 5 — No Action

Under the No Action alternative, methane seepage in the Project Area's west side would continue to increase through the year 2014, as predicted by the 3M Model. Methane seepage would then begin to diminish slowly beyond 2014. Alternative 5 would not change the current and projected extent and rate of methane seepage in the western Project Area. As with the other alternatives, concentrations of methane may increase in up to 39 shallow domestic wells, mostly in La Plata County, even with the current well field and no further development.

Methane seepage may also occur in the eastern Project Area because of development, of a cluster of 14 private mineral estate wells within a zone approximately ¾ mile to 1½ miles of the Fruitland Formation outcrop. However, the probability of methane seepage at the outcrop is lower than Alternatives 1, 2, and 7 because of the very limited development that would occur as a result of Alternative 5. If outcrop impacts were to occur, the extent of the outcrop affected by seepage may be confined, to areas immediately updip of the private minerals that would be developed. There would be no federal well development as a result of Alternative 5, and thus no contribution of federal wells to this potential impact. The mitigation and monitoring measures described in Section 3.3.10 are designed to address outcrop and property impacts from CBM development, should they occur.

3.3.6.2.4 Alternative 6

Within the western Project Area, methane seepage impacts would be the same as described for Alternative 1. As a consequence, the number of shallow domestic wells, seeps, and springs that may be affected by methane seepage would also increase. According to the state water engineer's database, 39 domestic water wells are situated on the outcrop of the Fruitland Formation (Figure 3–9). Any number of these wells may be affected with increased concentrations of methane.

In the eastern Project Area, the potential for methane seep related impacts would be generally less than predicted for Alternative 1 because there would be no federal wells drilled within 1½ miles of the Fruitland outcrop. The probability of CBM development triggering de-watering and/or contamination of domestic wells would therefore be low and approximately equal to Alternative 5 — the No-Action Alternative.

The mitigation and monitoring measures described in Section 3.3.10 are designed to address outcrop impacts that may be realized from CBM development.

3.3.6.2.5 Alternative 7

Within the western Project Area, impacts would be as described for Alternative 1. Methane seepage would be expected to increase in areal extent as a result of current development. Additional seeps may occur between Indian Creek and the Animas River drainage on the west (outside the Project Area), from the Pine River to the South Fork of Texas Creek, and from the Pine River east towards Beaver Creek (Figure 3–8). As a consequence, the number of shallow domestic wells, seeps, and springs that may be affected by methane seepage may also increase. Any number of the approximately 40 domestic water wells situated on the outcrop of the Fruitland Formation may be affected with increased concentrations of methane.

Within the eastern Project Area, the probability of methane seeps at the Fruitland outcrop would also be as described for Alternative 1. The 3M Model predicts increased methane seepage at the outcrop in the eastern Project Area as a result of new 320-acre or 160-acre CBM development. The area with greatest potential to trigger impacts is the zone of development ranging from ¾ mile to 1½ miles of the outcrop. As described above, the coal and hydrological characteristics suggest that widespread methane seeps may not occur or be extensive, as a result of CBM development in this zone. The monitoring program described in Section 3.3.10 is designed to detect and manage water well impacts if they were to occur.

Alternative 7 would first involve development of a cluster of approximately 15 wells, mostly on the private mineral estate in the Fosset Gulch Federal Unit in the eastern Project Area. Development would be monitored according to federal and state requirements for well performance, well interference, water production, and effects to domestic water wells, springs and seeps, and the Fruitland outcrop (Section 3.3.10). The production and monitoring data derived from the well cluster would then be used to condition subsequent development of federal leases in the Fosset Gulch Unit. This stepwise approach to the development of the near outcrop zone (¾ miles to 1½ miles) in the eastern Project Area would allow the orderly collection of production and monitoring data that would aid federal APD approvals.

3.3.6.3 Surface Water

Surface water that may be affected by CBM development is limited to springs emanating from the Fruitland Formation and the Pictured Cliffs Sandstone. The only known occurrences to date of surface water depletions related to CBM development are along areas of the outcrop located outside of the Project Area. Larger bodies of surface water in the Project Area's west side (Texas Creek; the Animas, Pine, and Florida Rivers) are already subject to methane seepage from naturally occurring methane seeps and from the current CBM well field. Anecdotal evidence suggests that the rate of methane seepage has increased in all these rivers with the onset of CBM development, and studies conducted by the BLM show a cause and effect relationship between CBM development and increasing methane seepage in the Pine River area.

In the western Project Area, impacts to surface waters connected to the Fruitland Formation or the Pictured Cliffs Sandstone may continue to increase over the next 10 to 20 years, but are not predicted to significantly intensify as a result of additional CBM development. In the eastern Project Area, very limited CBM development has occurred, and no CBM-related impacts to surface water emanating from the Fruitland Formation and the Pictured Cliffs Sandstone have been identified. CBM development is predicted to potentially impact surface waters emanating from the Fruitland Formation and the Pictured Cliffs Sandstone in the eastern Project Area, based on the conclusions of the 3M Model (Questa 2000) and Cox and others (2001).

It is possible that springs emanating from the outcrops of the Kirtland Shale and the Lewis Shale may be affected by methane seepage coming from the Fruitland Formation and Pictured Cliffs Sandstone as a result of erosion and fracture features that could provide possible near-surface flowpaths connecting the formations. Springs in the western Project Area have not been affected by CBM development over the past 6 years, however. (Carbon Junction, Edgemont Ranch, and other springs show no sign of active methane seepage.)

3.3.6.3.1 Alternative 1 — Proposed Action

In both the western and eastern Project Areas, there are no reported incidences of impacts to springs and seeps, in terms of either methane contamination or loss of flow due to CBM development. However, groundwater withdrawals can reduce the water table at the Fruitland outcrop and potentially impact the flow of hydrologically connected springs or seeps, or the springs and seeps can be contaminated by methane, as has been observed in areas along the Fruitland outcrop south of the Project Area.

In the western Project Area, the areal extent of methane seepage is predicted to increase (Questa 2000), and spring and seep contamination could, therefore, commence and increase commensurately.

Squaw Creek, at Yellowjacket Pass (Figure 3–10), may be subject methane seepage, and other springs and seeps along the eastern portion of the outcrop may also be affected by methane seepage as a result of proposed CBM development. The Piedra River likewise may be subject to methane seepage (Figure 3–10).

CBM wells that may have the most immediate impact on springs and seeps that emanate from the Fruitland Aquifer would generally be those proposed wells drilled from ¾ mile to 1½ miles from the Fruitland outcrop. The 3M Model predicts increases in seepage at the Fruitland outcrop in the eastern Project Area. However, as described above, the eastern Project Area coal and hydrological characteristics are such that wells producing within this near-outcrop zone may have a lower potential than western Project Area wells of triggering methane seeps that would impact springs, seeps, streams or the Piedra River. The mitigation and monitoring measures described in Section 3.3.10 are designed to detect changes in springs and seeps, to identify the causative factors, and to prevent or reduce impacts to surface waters if changes are detected.

There are no observable effects on water quality or aquatic life at the existing pre-CBM methane seeps in the Animas, Pine, and Florida Rivers. Increased

methane seepage to surface water bodies is not expected to affect other resources and would have negligible effects on surface water chemistry.

3.3.6.3.2 Alternative 2

Alternative 2 would likely be similar to Alternative 1 in terms of methane seepage rate and potential to impact springs, seeps and larger water bodies in the western and eastern Project Area. Impacts would be as a result of existing CBM development in the western Project Area and extensive new CBM development in the eastern Project Area.

As noted for Alternative 1, there are no observable effects on water quality or aquatic life at the existing pre-CBM methane seeps in the Animas, Pine, and Florida Rivers. Methane seepage to these large surface water bodies is not expected to affect other resources and would have negligible effects on surface water chemistry.

3.3.6.3.3 Alternative 5 — No Action

Potential for methane seepage impacts on springs, seeps, and other surface water bodies in the central and western Project Area would be similar to the other alternatives, because the existing well field would continue operating and infill CBM development would continue on private leases.

Squaw Creek, the Piedra River, and other small groundwater seeps and springs in the eastern portion of the Project Area would probably see little or no impact associated with CBM development. We expect little to no impact because the intensity of development in the near-outcrop area would lower than the other alternatives; therefore, the potential for methane seepage would be commensurately lower.

3.3.6.3.4 Alternative 6

The western Project Area methane seepage impacts to surface water bodies as a result of Alternative 6 would be the same as predicted for Alternative 1.

Development of the eastern Project Area would differ measurable from Alternative 1 because there would be no development of federal leases, and very limited development of private leases, within the 1½-mile near outcrop zone of the Fruitland Formation. Therefore, the potential for methane seeps, and particularly seeps impacting springs, seeps and other surface water bodies would be low. The monitoring described in Section 3.3.10 is designed to identify springs and to monitor change over time. COGCC could require alteration of private and state well operation or other measures to mitigate outcrop impacts if they were to occur. There would be no wells drilled on federal mineral estate.

3.3.6.3.5 Alternative 7

The impacts of Alternative 7 to surface water bodies would be same as Alternative 1 in the western Project Areas and similar to Alterative 1 in the eastern Project Area. The difference between Alternatives 1 and 7 is the way in which Alternative 7 would proceed with development in the Fosset Gulch Unit within the band of proposed wells that are ¾ mile to 1½ miles from the Fruitland outcrop. The stepwise approach of developing private leases before proceeding with fed-

eral leases would facilitate the collection of monitoring information that would aid in federal APD approvals and management of potential surface water impacts.

3.3.6.4 Vegetation

Current levels of methane seepage have affected an estimated 130 acres of vegetation. The areal extent of die off seems to have increased since the onset of CBM development and therefore CBM development along with other factors such as drought, has cumulatively affected vegetation. The total affected area is likely to increase somewhat in the western project area, even under a No Action alternative as a result of current CBM development and the additional development that would proceed on private mineral estate. The 3M Model predicts the increased areal extent methane seepage at the Fruitland outcrop (Figure 3–8 compared to Figure 3–7). Increases in methane seepage would affect larger areas of the outcrop and potentially expand the areas of dead vegetation between the Animas River and Beaver Creek.

In the eastern Project Area, dying vegetation has not been detected and the area has not been extensively developed. The 3M Model predicts increased methane seepage along the Fruitland outcrop in the eastern Project Area as a result of new CBM development. The methane seepage could, in turn, result in areas of dying vegetation.

3.3.6.4.1 Alternative 1 — Proposed Action

The proposed action may expand the acreage of plant die-off caused by methane seeps along the Fruitland Formation outcrop. Alternative 1 could expand the area of vegetation die off by an estimated 510 acres, in addition to the 130 acres affected by methane seepage

In the western Project Area, this increase in methane seepage and potential vegetation die-off would most likely occur along the outcrop between the Animas River and Beaver Creek.

The 3M Model likewise predicts increased methane seepage in the eastern Project Area as a result of new CBM development. This methane seepage could result in vegetation die-off. However, well development near the Fruitland outcrop in the eastern Project Area may have a lower potential of triggering methane seepage than the west side due to the characteristics of the area's coals. The monitoring described in Section 3.3.10 is designed to detect vegetation change at the outcrop and to monitor for increases in methane seepage, and the mitigation measures are designed to manage impacts if they were to occur.

3.3.6.4.2 Alternative 2

Vegetation impacts associated with Alternative 2 should be similar to those described under Alternative 1. As with Alternative 1, increased vegetation die-off may occur along the outcrop. As many as 510 additional acres of vegetation may be affected by CBM development within the Project area. The impacts would be the result of existing development in the western Project Area and new development in the eastern Project Area.

3.3.6.4.3 Alternative 5 — No Action

Vegetation die-off would be similar to Alternative 1 in the western Project Area due to existing development. Vegetation die-off could expand beyond the 130 acres that the existing CBM well field is predicted to affect. With predicted increased areal extent of methane seepage between the Animas River and Beaver Creek, the area of vegetation die-off could also increase in the western Project Area.

Some additional acreage may be affected in the eastern Project Area because of development of private mineral estate. However, CBM development is limited to 14 private and two state wells and because of the hydrological and coal characteristics, the potential for vegetation die-off in the eastern Project Area would be low.

3.3.6.4.4 Alternative 6

The western Project Area impacts of Alternative 6 would be the same as predicted for Alternative 1.

Development of the Project Area's east side would differ from Alternative 1 because there would be no development of federal leases within the 1½-mile near outcrop zone of the Fruitland Formation. Therefore, the potential for vegetation die off along the Fruitland outcrop in the eastern Project Area would be less than Alternative 1 due to limited development of private mineral estate within proximity of the Fruitland outcrop.

3.3.6.4.5 Alternative 7

The western Project Area impacts of Alternative 7 would be the same as predicted for Alternative 1.

The eastern Project Area impacts would be similar to Alternative 1. The 3M Model predicts increased methane seepage in the eastern Project Area as a result of new CBM development depicted in Figure 2–2 that could ultimately lead to vegetation die-off. However, the stepwise approach of developing private leases before proceeding with federal leases would allow the acquisition of monitoring information that would aid in developing federal APD approvals that address vegetation impacts.

3.3.6.5 Wildlife

The impacts on wildlife habitat caused by methane seepage are largely related to the vegetation die-off.

3.3.6.5.1 Alternative 1 — Proposed Action

The Proposed Action may expand the acreage of habitat loss due to increased vegetation die-off. The duration of this effect is unknown, because some of the methane seep areas begin vigorously and subside as production continues. Furthermore, some methane seep areas appear to persist.

Some plant life would be reestablished within several years in areas where the seeps subside. The new plant life could lead to a change in habitat, as grasses and shrubs eventually replace dead trees.

In contrast, the persistent seep areas do not allow for revegetation. Moreover, according to the results of the 3M Model, these seeps may persist for several centuries. The areas affected by methane seeps should gradually be reduced, as CBM wells are plugged and abandoned and the Fruitland aquifer begins to recharge.

3.3.6.5.2 Alternative 2

The affected areas are expected to be similar to Alternative 1 under Alternative 2. The timing and intensity of methane seeps may differ slightly between the two alternatives. The total loss of habitat may be on the order of 640 acres along the outcrop of the Fruitland Formation.

Maximum development of the CBM resource may lead to an early reduction in the intensity of the methane seep, as the wells nearest the outcrop would intercept some of the methane that would otherwise escape to the atmosphere at the seep areas. Maximum development thus could reduce the duration and intensity of the seep locally. We do not expect, however, that increasing the density of wells near the outcrop would measurably reduce the loss of wildlife habitat.

3.3.6.5.3 Alternative 5 — No Action

The No Action alternative would have the same habitat effects as Alternative 1 in the western Project Area due to existing development and continued development of private mineral estate. There may be some minor impacts from methane seepage induced by CBM development on private minerals in the eastern Project Area.

3.3.6.5.4 Alternative 6

The impacts to wildlife habitat would be the same as anticipated for Alternative 1 in the Project Area's west side.

In the eastern Project Area, the potential for habitat loss due to loss of vegetation would be less than Alternative 1 because there would be no development of federal mineral estate within 1½ miles of the Fruitland outcrop.

3.3.6.5.5 Alternative 7

The impacts to wildlife habitat would be the same as anticipated for Alternative 1 in the Project Area's west side.

In the eastern Project Area, the potential for habitat loss due to loss of vegetation would be similar to Alternative 1. Because there would be development of federal mineral estate between ¾ mile and 1½ miles of the Fruitland outcrop, there would be potential for vegetation/habitat impacts along the Fruitland Formation outcrop

3.3.6.6 Soils

As with vegetation and wildlife, methane seepage would affect a larger area of soils with any development scenario. Methane seeps increase susceptibility to erosion, by removal of the root structure through vegetation die-offs. In addition, methane seepage may alter some physical characteristics of the soil.

3.3.6.6.1 Alternative 1 — Proposed Action

Because of vegetation die-off, additional bare soils may be exposed on the outcrop of the Fruitland Formation. These soils would be susceptible to accelerated erosion.

3.3.6.6.2 Alternative 2

This alternative would also have a potential for additional exposed soil on the outcrop and the concomitant increased potential for erosion.

3.3.6.6.3 Alternative 5 — No Action

This alternative would potentially affect additional acres of soils as a result of current and projected CBM development of private and state leases in the western Project Area. Vegetation die-off and consequent effects to soils in the eastern Project Area would probably be minimal due to very limited CBM development on private mineral estate.

3.3.6.6.4 Alternative 6

The impacts of this alternative would be the same as Alternative 1 in the western Project Area. Additional area of bare soils may be exposed on the outcrop of the Fruitland Formation, primarily in the western Project Area. These soils would be susceptible to accelerated erosion.

Eastern Project Area impacts to vegetation and soils would be less than Alternative 1, because there would be no development of federal leases within 1 ½ miles of the Fruitland formation.

3.3.6.6.5 Alternative 7

The impacts of Alternative 7 would similar to Alternative 1.

3.3.6.7 Human Health and Safety

There are approximately 60 residential type structures on the outcrop of the Fruitland Formation the Project Area (Figure 3–11). These structures may be affected by methane seepage and buildup associated with CBM development in the area, although most structures on the Fruitland outcrop are built to ventilate gas, thereby greatly reducing potential safety impacts.

Other impacts on human health and safety are associated with current CBM development. We do not expect additional impacts, however, as long as La Plata County continues to monitor building activities on the outcrop of the Fruitland Formation. There may be a risk in that structures could be built on the outcrop without proper ventilation designs if Archuleta County does not monitor building activities

3.3.6.7.1 Alternative 1 — Proposed Action

The 60 structures along the outcrop may be affected by methane seepage, thus exposing any residents to safety risks.

3.3.6.7.2 Alternative 2

The 60 structures along the outcrop may be affected by methane seepage, thus exposing any residents to safety risks.

3.3.6.7.3 Alternative 5 — No Action

CBM development on private mineral estate may affect the structures on the outcrop of the Fruitland Formation in Archuleta County. The potential for this impact to occur would be reduced, however, with the lower intensity of development in this area. Potential impacts to structures in La Plata County would be similar to Alternative 1.

3.3.6.7.4 Alternative 6

Similar to Alternative 1, approximately 60 structures along the outcrop may be affected by methane seepage, thus exposing any residents to safety risks. However, by not developing wells on federal mineral estate in the 1½ mile near outcrop zone, Alternative 6 would present a lower risk than Alternative 1 of impacting structures in Archuleta County.

3.3.6.7.5 Alternative 7

Approximately 60 structures along the outcrop may be affected by methane seepage, thus exposing any residents to safety risks. However, stepwise development of wells in the zone ¾ mile to 1½ miles of the outcrop would present the opportunity to monitor private mineral estate development prior to proceeding with APD approvals on federal mineral estate. Mitigation and monitoring measures described in Section 3.3.10 are designed to detect methane seeps, help predict the potential for future seeps, and to protect property owners if property is affected.

3.3.6.8 Loss of Gas Resource

The baseline for comparison of alternatives is current development in the western project area and 320- acre well spacing in the eastern project area. Methane seepage rates for this scenario are displayed in Table 3-6. Baseline development and all of the alternatives result in a loss of the gas resource, caused by acceleration of methane seepage at the outcrop. Infill development results in peak methane seepage occurring around 2014 while baseline development would peak around 2024.

Infill wells have a mitigating effect on methane seepage. In other words, beyond 2020, methane seepage is projected to be lower with infill wells than without infill wells, and cumulative seepage to 2035 is projected to be lower with infill wells (Table 3-6). Differences among the alternatives may be assessed qualitatively using the results of the 3M Model. In light of the uncertainties associated with the model predictions and model input, however, any quantitative differences between alternatives are speculative.

Table 3-6 Methane Seepage Rates—Comparison of Alternatives

	Daily Rate (Mcfd)[1]	Annual Rate (MMcf)[1]	Cumulative Loss (MMcf)[1]
Baseline: Current wells in western project area and 320 acre well spacing in eastern Project Area			
Current	3,420	1,240	6,200
Maximum (Yr. 2023)	4,740	1,730	
Year 2035	4,200	1,530	54,300
Alternative 1: Infill development 160 acre spacing as shown in Figure 2–2			
Current	3,460	1,260	6,200
Maximum (Yr. 2014)	5,040	1,840	
Year 2035	3,320	1,211	53,800
Alternative 2: Maximum Infill development as shown in Figure 2–3			
Current	3,460	1,387	6,200
Maximum (Yr. 2014)	5,040	1,840	
Year 2035	3,320	1,716	53,800

Notes:
1. Mcfd = 1,000 standard cubic feet per day; MMcf = 1 million standard cubic feet

Below is a description, in qualitative terms, of the relative amounts of lost resource that may be expected. Year 2005 was used to establish baseline conditions and then to compare each alternative against the baseline. These baseline conditions were simulated with the year 2000 CBM well field. The discussion for each alternative points out factors that may cause these differences.

3.3.6.8.1 Alternative 1 — Proposed Action

Alternative 1 would develop both the western and eastern Project Area to a density of 160-acre spacing over much of the available drilling windows (Figure 2–2). The Proposed Action would increase the amount of methane lost from seepage at the outcrop areas, and result in new seeps in the western and eastern Project Area. At present, the eastern portion of the Project Area is unaffected by CBM development. With the beginning of development, however, approximately 15 miles of outcrop area may be subject to increased seepage. The probable trajectory of change in methane seepage would mimic Alternative 2 (Table 2-2), resulting in a peak level of seepage occurring around 2014,as opposed to 2024 for the baseline 320-acre spacing scenario (Figure 3–6). The peak would also be higher than the 320-acre spacing peak, but long-term cumulative methane seepage would be lower than baseline due to the long-term mitigating effect of infill wells.

3.3.6.8.2 Alternative 2

Overall, methane seepage would be as projected in Figure 3–6 and Table 3-5. Maximum infill development would result in methane seepage peaking around 2014 at a higher level than projected for baseline 320-acre spacing which would peak around 2024. Over the long term, the infill wells depicted in Figure 2–3 would have a mitigating effect, intercepting some of the methane gas that would be lost to the atmosphere under the baseline 320-acre spacing scenario.

3.3.6.8.3 Alternative 5 — No Action

Alternative 5 would result in much the same CBM development as Alternative 1 in the western Project Area, and therefore the same methane seepage effects. In the eastern Project Area, there would be development of 14 private and two state locations only. This limited development, compared to Alternative 1 would probably not result in measurable changes in methane seepage at the Fruitland outcrop. Consequently, the cumulative methane seepage predicted for Alternative 5 would be lower than predicted for Alternative 2 (Table 3-5). Peak seepage in the western Project Area would occur around 2014 and would probably be higher than the baseline 320-acre spacing scenario, but over time the infill wells would have a mitigating effect.

3.3.6.8.4 Alternative 6

Alternative 6 methane seepage would likely mimic Alternative 5, the No Action Alternative. There would be no development within the 1½-mile near outcrop zone in the eastern Project Area and very limited development of the eastern Project Area, overall. Consequently, there would be no measurable change in Fruitland outcrop condition and seepage rate in the eastern Project Area. The western Project Area would experience the same level and timing of seepage as the other alternatives, with methane seepage peaking around 2014 and infill wells slightly mitigating seepage impacts over the long term. Overall methane seepage under Alternative 6 would be less than Alternatives 1, 2, and 7, but potentially greater than Alterative 5.

3.3.6.8.5 Alternative 7

The rate and cumulative amount of methane seepage realized from Alterative 7 would be similar to Alternative 1. Consequently, methane seepage would peak around 2014 (Table 3-5) as opposed to 2024 under the baseline 320 acre spacing projection. Over time, the infill wells would have a slight mitigating effect, resulting in lower seep rates than would be projected under 320-acre well spacing.

In the eastern Project area, which is mostly undeveloped, CBM wells would be developed at 160-acre spacing as depicted in Figure 2–6. This new development could trigger methane seepage over portions of a 15-mile band of Fruitland outcrop that does not currently have measurable seepage. The 3M Model simulations of eastern Project Area impacts, predict increased seepage at the outcrop under both 320-acre spacing and 160-acre spacing. Because the eastern Project Area has experienced only limited development, however, the prediction of outcrop impacts are at this time speculative. Coal characteristics suggest that outcrop impacts may be limited or may be delayed in comparison to the trajectories predicted for the western Project Area.

3.3.7 Environmental Consequences — Hydrogen Sulfide Seepage: Outcrop

As described above, no hydrogen sulfide seeps in the Project Area can be directly associated with CBM development. Numerous monitoring points on the outcrop immediately south and west of the Project Area show a statistically significant increase in hydrogen sulfide. There is a direct correlation between CBM well

operation and large water-table drawdowns in the Fruitland Formation near the outcrop in the area southwest of the Project Area. The drawdowns are also correlated with increasing concentrations of hydrogen sulfide measured in the vapor tubes.

It is thought that the lower water table exposes previously anoxic coal beds to oxidizing recharge water. This exposure oxidizes sulfide minerals in the coals and transports the sulfate downdip. The sulfate is food for the sulfate-reducing bacteria at depth and creates hydrogen sulfide seeps.

The potential for development of hydrogen sulfide seeps can be assessed by alternative in relative terms. The following discussion, however, is based solely on data collected from vapor monitoring tubes outside of the Project Area. Therefore, it should not be considered an impact that would definitely occur.

3.3.7.1 Alternative 1 — Proposed Action

The potential for the development of hydrogen sulfide seeps would be increased, because Alternative 1 would expand the effects of CBM development over a larger portion of the outcrop belt. Seeps of hydrogen sulfide appear to be confined to specific subsurface conditions. The larger the area of the outcrop affected by CBM development, the greater the likelihood that these conditions may be encountered.

3.3.7.2 Alternative 2

We expect that the potential to induce seeps of hydrogen sulfide would be slightly greater under Alternative 2, compared with Alternative 1, because more wells would be installed nearer the outcrop, thus increasing the potential for creating the conditions for generating hydrogen sulfide along the outcrop.

3.3.7.3 Alternative 5 — No Action

The potential to induce seeps of hydrogen sulfide under this alternative would be lower, because a smaller area of the outcrop would be affected by CBM development, compared with Alternatives 1 and 2.

3.3.7.4 Alternative 6

The potential to induce seeps of hydrogen sulfide under Alternative 6 would be similar to Alternative 5.

3.3.7.5 Alternative 7

The potential to induce seeps of hydrogen sulfide under Alternative 7 would be similar to Alternative 1.

3.3.8 Cumulative Effects

The environmental effects of methane seepage were discussed in detail in the previous sections relating to effects of methane seepage on each resource. In additional to methane seepage within the immediate Project Area, seepage has been detected and shown to be increasing along the Fruitland outcrop west of the Pro-

ject Area. This additional area is Area A and portions of Area B in the 3M Model and extends along the Fruitland outcrop from the Colorado – New Mexico State border to the Animas River. 3M simulation runs predict that methane seepage will increase and a peak rate would be reached in 2011. Infill wells area expected to reduce seepage after 2011. Overall, within the cumulative effects area, the 3M Model predicts that seepage will peak at 10 MMcfd, or about twice the current level, and cumulative seepage is predicted to reach more than 100 billion cubic feet (bcf) by 2030 (Questa 2000). Projected seepage locations are generally clustered around the area of existing seeps and would increase in areal extent as shown in Figure 3–8. Additional seepage could also emerge in the eastern Project Area as a result of the onset of CBM development in this relatively undeveloped area.

For all alternatives, additional impacts from hydrogen sulfide are difficult to predict based on past experience. It is expected that highly localized hydrogen sulfide seeps may develop on the outcrop; however, to date, only two known hydrogen seeps have been identified in the Project Area. Only one of the seeps may be tied to CBM development.

This section summarizes the expected cumulative effects for each alternative.

3.3.8.1 Alternative 1 — Proposed Action

The industry proposed action may trigger methane seepage which can, in turn, affect soils, surface water, groundwater, human health and safety, and vegetation on approximately 510 additional acres on the outcrop. It would also increase the loss of gas resource to the atmosphere. Lastly, we anticipate that some additional domestic wells on the outcrop would be contaminated by methane seepage.

Cumulatively, these above impacts would occur over a larger area of Fruitland outcrop than in the Project Area. The area of similar concern for Fruitland outcrop impacts is the area between Valencia Canyon and the Animas River to the west of the Project Area. This area has experienced measurable increases in methane seepage since the onset of CBM development and is predicted to continue to increase in volume of seepage at least through 2007, and then begin to slowly decline (Questa 2000). As described above, maximum annual seepage will peak at 10 MMcfd, or about twice the current level, and cumulative seepage is predicted to reach more than 100 bcf by 2030 (Questa 2000).

3.3.8.2 Alternative 2

Cumulative impacts would be similar to Alternative 1.

3.3.8.3 Alternative 5 — No Action

Cumulative impacts would be less than those described for all other alternatives because a smaller portion of the outcrop would be affected by methane seeps.

3.3.8.4 Alternative 6

Cumulative impacts would be similar to Alternative 5.

3.3.8.5 Alternative 7

Cumulative impacts would be similar to Alternative 1.

3.3.9 Conformance to Existing Plans and Policies

For all alternatives, existing and proposed CBM development would conform with current Notices to Lessees and State and Federal regulations for gas well completion and production in the Fruitland Formation. This would continue to prevent methane seepage along gas well bores.

3.3.10 Mitigation and Monitoring

Unless otherwise stated, the following mitigation and monitoring measures would be funded by the companies.

3.3.10.1 Monitoring

The following monitoring measures apply to federal CBM wells proposed within the 1.5-mile Fruitland outcrop buffer zone and not necessarily to other federal CBM wells in the Project Area. Many of these measures have been implemented as required by the COGCC and BLM. A number of these monitoring requirements are programmatic, meaning that they apply comprehensively to the Fruitland Formation outcrop in the NSJB in addition to lands inside the Project Area. The appropriate set of requirements for any proposed federal CBM well would be determined on a case-by-case basis. Additional measures may be required, modified, or may be discontinued as field data is collected and the mechanisms of gas seepage and ground/surface water depletions are better understood.

Companies are to submit annual monitoring report(s) to the BLM and FS or to an entity funded by the companies charged with data administration and review. The goal of the monitoring and reporting requirement is to provide for early detection, prevention and/or mitigation of potential methane seepage, water depletion, and water quality impacts related to CBM development. These requirements include:

- Conduct water table monitoring in gas seep areas.
- Fruitland Outcrop Reconnaissance — before operations commence and then every third year, conduct low altitude, high-resolution aerial photography to map the vegetation on and immediately adjacent to the Fruitland outcrop. This work would coincide with and be tied into similar work conducted in La Plata County under COGCC Orders 112–156 and 112–157. Identify "suspect" areas requiring further field investigation. Locate the suspect areas and survey for the presence or absence of methane, carbon monoxide, and hydrogen sulfide. If methane seeps or seeps of other gases from the outcrop of the Fruitland Formation are identified, then implement a plan for mapping the seeps in detail and monitoring the seeps to identify any changes in extent of impacted area, and volume, concentration, composition, and stable isotope ratios. Attempt to identify the cause of the changes.

- Post Completion Pressure Build-Up Test — after well completion and prior to sales, make a bottom hole pressure measurement using a bottom hole gauge after a 48-hour shut-in period, provide these data to BLM and COGCC within one month of conducting each test.
- Plugged and Abandoned Wells – Identify all plugged and abandoned (P&A) wells located within one mile of a proposed well location. Any P&A well within one mile of a proposed well that is identified shall be assessed for risk taking into account cementing practices reported in the P&A. The operator shall notify the BLM and COGCC of the risk assessment of plugging procedures. The risk assessment shall be reviewed and appropriate action taken to pursue further investigation and remediation if warranted.
- Soil Gas Survey — Prior to beginning well production, conduct a soil gas survey around any well identified through the P&A well risk assessment described above. This includes establishment of at least one permanent soil monitoring probe (vapor tube), and surveying the area on an annual basis.
- Emergency Preparedness Plan (EPP) — Submit an EPP to Archuleta County or La Plata County as applicable. The EPP shall include as-built facilities maps showing the location of wells, pipelines, and other facilities, except control valve locations that may be held confidential. The EPP shall include an emergency personnel contact list, that must be updated whenever the contact information changes.

3.3.10.1.1 Methane and H_2S Seepage Monitoring Program

- Continue bimonthly monitoring of 180 existing vapor tubes (soil gas flow rates, methane, oxygen, hydrogen sulfide, and carbon dioxide content in the shallow gases) at 12 existing transects along the outcrop. (New tubes were added at Beaver Meadows Road and Yellowjacket Pass in 2001.)
- Add vapor tube transects at the Florida River, Edgemont Ranch, Fosset Gulch Road, and the Piedra River area.
- Conduct statistical-trend analysis of methane seep data annually.
- Conduct aerial infrared photography survey of outcrop, as described above, once every three years. This infrared imagery is used to identify vegetation changes, to supplement the pedestrian surveys, and provide a regular photographic record of the conditions at the outcrop.
- Conduct pedestrian surveys of the outcrop annually to identify recent vegetation die-offs, map the affected areas, and sample subsurface-soil gas to evaluate whether active methane seepage is responsible for die-offs. Revegetation at previously mapped seepage locations should also be noted.

3.3.10.1.2 Groundwater Monitoring

- Install groundwater-monitoring wells and/or shallow piezometers along the outcrop of the Fruitland Formation, to evaluate whether the effects of CBM dewatering extend to the outcrop in all areas, or whether portions of the outcrop may be hydraulically isolated from the down dip produc-

ing areas. Initially, the primary focus of groundwater-level monitoring will be to monitor shallow, near-outcrop water levels, but there may also be a need for deeper wells, located further from the outcrop to monitor down-hole pressure and groundwater levels to provide comprehensive information about Fruitland Formation hydrogeology.

- Quantify the overall water balance, including recharge and discharge, of the Fruitland Formation and Pictured Cliffs Sandstone and develop a monitoring program that can provide early detection of groundwater impacts. Should this prove to be technically and economically feasible, the agencies and operators would explore whether to proceed with implementing the study.
- Fruitland Outcrop Spring Survey — Conduct a regional reconnaissance survey to identify all springs that emanate from the outcrop of the Fruitland Formation. Thereafter, survey these springs on an annual basis at approximately the same time of the year as the initial survey. Ideally, inspections of springs would be repeated at low flow periods, like late summer, for comparison purposes. At a minimum, test for and measure methane concentration, water chemistry, and flow rate.
- Continue to inventory springs, wells, and groundwater seeps (wetlands) along the outcrop of the Pictured Cliffs and Fruitland and Kirtland Formations.
- Groundwater Monitoring Program — On an annual basis, monitor water wells within one-half mile of the Fruitland outcrop following the procedures established in COGCC Orders 112–156 and 112–157. Prior to well drilling activities, provide the BLM and the FS a list of all tested water wells, the analytical results, and the locations surveyed using GPS or other accurate method. Provide the BLM, FS, COGCC and the property owner with copies of all test results within 3 months of collecting the samples used for the test.
- Continue monitoring water levels at the Walker well (Texas Creek), the Meloche well (Pine River area – Kirtland Formation), and the Bureau of Reclamation piezometers in the Ridges Basin area.
- Monitor water levels at springs and wells, measure flows at springs (download dataloggers and maintain database).
- Collect time-series water chemistry and temperature data from producing CBM wells.
- Submit annual reports documenting conditions and highlighting changes that may be due to weather/climate or CBM development activities.
- Provide copies to the BLM and FS of the water monitoring reports required by COGCC Order No. 112–156.

3.3.10.1.3 CBM Produced-Water Chemistry Time-Series Sampling

Sample producing wells located within 3 miles of the Fruitland/Pictured Cliffs contact and analyze for common ions, pH, total dissolved solids (TDS), and wellhead fluid temperature quarterly (once every 3 months) for 1 year. The initial water sample would be analyzed for the stable isotopes of hydrogen and oxygen. After the initial four samples have been collected, sampling would occur every

6 months for the next 2 years. The data would be evaluated after this 3-year period to decide whether this program should continue

Water Chemistry Monitoring — Private Wells

Continue to collect water samples from water wells as required by COGCC Orders 112–156 and 112–157 and by similar monitoring requirements adopted by the FS and BLM for wells in Archuleta County. Sample wells for concentrations of methane, as well as the major cation and anion components of groundwater. Methane detected above the threshold level of 1.0 mg/L would then be analyzed for isotopic composition. Analyze the isotopic composition of samples to obtain information on the origins of the methane (biogenic vs. thermogenic). Submit results to the BLM and FS as part of the annual monitoring report described above.

The purpose of these water chemistry sampling efforts is to monitor for changes in water quality and to document changes, if any.

Climatic/Weather-Monitoring Station

- Install a continuous weather-monitoring station on National Forest near or on the Fruitland Outcrop. Data collected from this station would include wind speed and direction, barometric pressure, precipitation, and temperature. These data would be used in evaluating vapor tube flow rates and concentrations of methane, as well as for air modeling input and calibration.
- Use precipitation data in evaluating data on water level collected at monitoring wells, springs, and seeps. Data on precipitation are critical for evaluating recharge potential along the outcrop and natural versus human-induced fluctuations in groundwater.
- Compile and issue data reports annually, noting deviations from regional long-term climatic averages.

3.3.10.1.4 Integration with Other Monitoring Efforts

BLM and FS would continue to work with the COGCC and the gas industry to achieve a unified, comprehensive, efficient, and non-duplicative water and gas seepage monitoring and mitigation plan for the Project Area.

- The COGCC is conducting a monitoring effort that includes maintaining six flux pyramids, annual surveys of the outcrop, and installing and monitoring deep monitoring wells.
- BP America is continuing to monitor the Pine River area, which consists of flux pyramids and monitoring wells. Two flux pyramids are installed in the channel of the Pine River. These locations were selected to capture methane from active seeps in the riverbed. BP also collects water-level data from the Gurr Federal, Salmon shallow, intermediate, and deep wells, the Pole Barn monitoring well, and the Morgan's house well.

The monitoring efforts described above are intended to complement these ongoing efforts.

3.3.10.1.5 Fruitland Outcrop Zone Monitoring Program — Fosset Gulch Federal Unit

The following monitoring requirements would apply to wells drilled in the Fruitland Formation outcrop zone, defined as the area bounded by a line 1½ miles basin ward of the outcrop contact between the Fruitland Formation and the Kirtland Formation. The COGCC has established these requirements for private mineral estate wells drilled in the Fosset Gulch area that are within ¾-mile to 1½-mile proximity of the Fruitland Formation outcrop. These same requirements would be applied as conditions of approval for federal wells within the same area:

- Fruitland Outcrop Reconnaissance — During 2005 and then on an every 3-year basis (e.g. 2008, 2011, etc), a low altitude, high-resolution aerial photography will be used to map the vegetation along the Fruitland Formation outcrop in those sections of land in T34N R5W, South of Ute Line (SUL) and Sections 9,13,14,15, and 16 in T34N R5W, North of Ute Line (NUL) in which the Fruitland Formation outcrops. This work will coincide with and be tied into similar work conducted in La Plata County under COGCC Orders 112–156 and 112–157. Once the aerial imagery is reviewed, "suspect" areas requiring further field investigation will be identified. Using a GPS and the IR imagery the suspect areas will be located and surveyed for the presence or absence of methane, carbon monoxide, and hydrogen sulfide. If methane seeps or seeps of other gases from the outcrop of the Fruitland Formation are identified, then the operator shall develop a plan for mapping the seeps in detail and monitoring the seeps to identify any changes in extent of impacted area, and volume, concentration, composition, and stable isotope ratios. In addition, the operator shall attempt to identify the cause of the changes.
- Fruitland Outcrop Spring Survey — during summer 2005 an initial regional reconnaissance survey to identify all springs that emanate from or that appear to emanate from the outcrop of the Fruitland Formation in T34N R5W SUL and Sections 9, 13, 14, 15, and 16 in T34N R5W NUL shall be surveyed, including accurately locating each spring using GPS or other land survey technology. Thereafter these springs shall be visited on an annual basis at approximately the same time of the year as the 2005 survey. At a minimum, methane concentration, water chemistry, and flow rate shall be tested and measured.
- Groundwater Monitoring Program — On an annual basis the operator will monitor private water wells in those sections of land in T34N R5W SUL and Sections 9, 13, 14, 15, and 16 in T34N R5W, NUL in which the Fruitland Formation outcrops following the parameters established in COGCC Orders 112–156 and 112–157. Prior to start up of any drilling activities, the operator shall provide the COGCC and BLM with a list of all tested water wells, the analytical results, and the locations surveyed using GPS or other accurate method. Copies of all test results shall be provided to the COGCC, BLM and the property owner within 3 months of collecting the samples used for the test.
- Produced Water Limitations — The operator shall limit water production to less than 100 barrels of water per day per well. Once the wells are online and producing and drilling and completion fluids have been removed from the wells, the operator shall collect one water sample from

each well and analyze these samples for major anions and cations, TDS, pH, conductivity, and other parameters as appropriate. These data shall be provided to the COGCC and BLM within 3 months of sample collection by

- Post Completion Pressure Build-Up Test — after completion and prior to sales a bottom hole pressure measurement must be made using a bottom hole gauge after a 48 hour shut-in period. The operator shall provide these data to the COGCC and BLM within one month of conducting each test.
- Soil Gas Survey — The Big Horn-Schomburg #1 (05–007–05100) well is located in SESE Section 14 T34N R5W. This well was drill and abandoned in 1961 and from the records available to the COGCC it appears that the top of the Fruitland Formation is close to or comes to the ground surface at this location. Prior to beginning production of any of the proposed wells, the operator shall conduct a soil gas survey around this well, shall establish at least one permanent soil monitoring probe (vapor tube) at this location, and shall survey the area on an annual basis. See #7 below for additional requirements regarding this DA well.
- Plugged and Abandoned Wells — The operator shall identify all P&A wells located within one mile of a proposed well location. Any P&A well within one mile of a proposed well that is identified shall be assessed for risk taking into account cementing practices reported in the P&A. The operator shall notify the COGCC and BLM of the risk assessment of plugging procedures. The agencies shall review the risk assessment and take appropriate action to pursue further investigation and remediation if warranted.
- Emergency Preparedness Plan — The operator shall submit an EPP to Archuleta County. The EPP shall include as-built facilities maps showing the location of wells, pipelines, and other facilities, except control valve locations that may be held confidential. The EPP shall include an emergency personnel contact list, that must be updated whenever the contact information changes.

3.3.10.2 Mitigation

In addition to the design features of the alternatives developed to avoid impact, the federal land managers, State of Colorado (COGCC), and the development companies are considering a range of comprehensive mitigation strategies to reduce methane seepage. The following mitigation measures would be available as described below as part of a comprehensive management approach to address gas seepage and water depletion impacts if they occur. LTE and the La Plata Energy Council are also in the process of investigating a range of methane seep mitigation approaches that may result in an expanded list of mitigation options that would be available during project implementation:

- Construct a series of closely spaced shallow wells immediately downdip of the coal bed outcrops using horizontal, directional, or conventional drilling methods. These wells would be operated under suction to recover methane as it migrates from the deeper basin region toward the outcrop. Should this approach prove technically and economically feasible, the

agencies and operators will explore its further application as a mitigation measure.

- Re-inject CBM produced water proximal to or within the outcrop to offset water depletion impacts as well as increasing hydrostatic head on the Fruitland gas reservoir to reduce gas seepage. Should this technique prove technically and economically feasible, the agencies and operators will explore its further application as a mitigation measure.
- Reclaim areas of vegetation stress and die-off. Reclamation methods may include prevention of methane seepage into soil using vapor-barrier or collection technology, removal of dead vegetation, revegetation of bare soil areas once methane seepage has been controlled, reducing erosion and sedimentation of bare soil areas using best management practices (BMPs), such as recontouring, ditching, storm water control plans, etc.
- Limit CBM well water production to less than 100 barrels of water per day per well to prevent or upon detection of adverse methane seepage or water depletion impacts related to CBM production from federal gas wells. Once the wells are online and producing and drilling and completion fluids have been removed from the wells, the operator shall collect one water sample from each well and analyze these samples for major anions and cations, TDS, pH, conductivity, and other parameters as appropriate. These data shall be provided to the BLM, FS, and COGCC within 3 months of sample collection.
- Federal gas wells that are shown to be causing methane seepage and/or water depletion impacts to critical resources may be shut-in on a case-by-case basis to temporarily or permanently halt water and gas production. Critical resources include private property, domestic water wells, perennial water sources such as springs and rivers, and areas of critical wildlife habitat.
- Recommend that Archuleta County prepare and implement building regulations for the area on and immediately adjacent to the Fruitland outcrop similar to those in La Plata County.

3.3.10.2.1 Property Impacts

The following mitigation approaches address operator responsibility, liability, and response to potential private property impacts:

- If reasonable evidence indicates that CBM development has impacted water well quantity or degraded water quality to less than State drinking water standards, the operator will replace the lost quantity of well water and/or treat or replace well water that has been degraded with water that meets State drinking water standards. This monitoring approach prescribes baseline monitoring of private wells as described above to detect change in water well quantity and quantity.
- If monitoring identifies potentially dangerous gas seeps that threaten existing residences or critical resources, the operator will clearly identify the seep area on the ground if it presents an immediate hazard to human health and safety and utilize the best management practices available to mitigate methane seepage (e.g., fans, improved ventilation, physical gas barriers, gas detection systems, etc.). This monitoring prescribes baseline

monitoring to establish current methane levels in residences along the Fruitland Formation outcrop. Any new residences constructed on the Fruitland Formation outcrop would meet county construction standards that incorporate methane mitigation construction approaches.

- If monitoring indicates a loss of vegetation (trees, pasture) or loss of land use due to the drying up of a spring as a result of CBM development, the operator will compensate the affected property owner for the loss of such property value.

3.3.10.2.2 Mechanism for Addressing Property Impacts

Fruitland outcrop impacts, if they were to occur, would generally be located on federal or private land within proximity of the leases on which CBM wells are drilled. To establish a mechanism for addressing potential private property impacts incurred off-lease, the federal agencies would require the following of the CBM producers, in addition to the monitoring outlined above:

- As a condition of federal gas well approval, producers will be required to offer a property owner agreement or bond agreement to potentially affected parties that addresses monitoring and measurement protocols, forms of mitigation, and/or compensation for damages that may result from gas production along or near the Fruitland outcrop. The particular environmental effects to be addressed in such property owner agreements are those identified in Sections 3.3.6 and 3.3.10.2.1 of this analysis and include but are not limited to the reduction, interruption, or contamination of domestic and agricultural waters, health and safety concerns centered around potential methane seepage, and the loss of vegetation or soil productivity due to methane seepage.

    - Potentially affected parties include all property or water well owners located on the Fruitland Formation outcrop and the area ½ mile basinward of the outcrop falling within 1½ miles of any point along a proposed gas well bore, when the gas well bore is plotted as a surface feature.

    - Producers will be required to identify and contact potentially affected parties prior to completion of the permitting process. Producers will be required to offer property owner agreements to mitigate the key concerns of water and of methane seepage to potentially affected parties and to provide evidence of such offers to the federal agencies as part of their application for permits to drill.

- The goal of the required property owner agreements would be to effectively and equitable address the projected effects of drilling and producing coal bed methane near and along the Fruitland outcrop. The federal agencies recognize that there may indeed be preferred approaches to mitigating effects to property owners that fall outside of the agencies' authority. For instance, as suggested during public comment, producers and affected property owners alike may find it advantageous to organize and pool resources to implement a mitigation fund (an example is provided in Appendix N) to address compensation of property owners that experi-

ence property impacts due to CBM development. Such a mitigation approach could prove more efficient for producers and property owners in terms of development and implementation of the action, and could provide greater levels of surety for all participants. Such a fund is established to address the same concerns outlined above, and where participation in the mitigation fund is offered to those property owners with land or water sources located on, or within close proximity of the Fruitland Formation and Pictured Cliffs Sandstone outcrop/subcrop along the San Juan Basin Rim in La Plata County and Archuleta Counties, Colorado, could prove a more effective substitute for individual property owner agreements.

3.3.11 Unavoidable Adverse Effects

Unavoidable adverse effects are those that cannot be eliminated, even through best management practices or other mitigation measures. For all alternatives, some level of methane seepage will occur; therefore, methane seepage and the inter-related effects on other resources are all considered unavoidable adverse effects.

The magnitude of these effects is described for each alternative in the previous sections.

3.3.12 Irreversible and Irretrievable Effects

Methane seepage at the outcrop represents an irreversible and irretrievable effect due to the methane loss to the atmosphere. Methane seepage effects on other resources, although long-term, will be time-limited. After CBM production ceases, and the groundwater recharges the coal beds, methane seepage will decrease, and in many places, it will cease.

3.4 Geology and Minerals

3.4.1 Issues

This section discusses the affected environment and probable environmental effects of CBM development on the geology, mineral and energy resources, and paleontologic resources of the Project Area. Analysis of landslide and slope stability issues is presented on a jurisdictional basis (e.g., National Forest, BLM, and then collective Project Area). Analyses of the issues of ground subsidence, subsurface geologic stability, and coal fires are presented on a Project Area wide basis because on meaningful distinction can be made between development effects of any one jurisdiction. The following issues were identified during the scoping process for this EIS.

Issue 5: The effects of additional development of CBM resources on the geology, geomorphology or topography, geohazards, paleontology, and mineral resources of the Project Area.

Sub-issues:

- Will surface disturbance associated with additional CBM development affect the landforms and physical landscapes of the Project Area?
- Will additional CBM development affect the geology of the Project Area?
- Will additional CBM development affect paleontologic resources?
- Will additional CBM development affect the mining of coal or the development of other mineral resources in the Project Area?
- Will surface disturbance associated with the construction of additional roads and well pads affect existing landslides and slope stability or increase the likelihood of new slope movements?
- Will injection of produced water affect the geologic stability of the subsurface?
- Will extraction of groundwater from the Fruitland Formation affect the geologic stability of the subsurface?
- Does hydraulic fracturing or cavitation affect the geologic stability of the subsurface?
- Will additional CBM development affect existing coal fires or increase the likelihood that new coal fires would ignite spontaneously in the Project Area?

Each sub-issue is addressed below, including the background, concerns, and effects of CBM development to date.

3.4.2 Affected Environment

3.4.2.1 Landforms/Physical Landscapes

3.4.2.1.1 Background

Physiography

The Project Area lies entirely in Colorado, within the Colorado Plateau physiographic province. This province extends throughout western Colorado, northwestern New Mexico, northeastern Arizona, and southern and eastern Utah. Characteristics of this physiographic province include an expansive, dissected, high-elevation land surface with relatively low relief when compared with surrounding mountainous regions.

Canyons, cliffs, elevated plains, low plateaus, mesas, buttes, and badlands dominate the landscape of this ecological region. Arroyos, valleys, and canyons were formed by stream erosion and intense storms. Landforms such as ridges, cuestas, cliffs, steep-sided mesas, and buttes were formed by differential erosion of rocks with alternating high and low resistance to erosion, often accompanied by local folding and faulting. Features called monoclines occur where layers of relatively flat-lying younger rock have been compressed and folded upward in one direction over older, faulted rocks. Many monoclines are long, winding features with considerable relief. The continuity of rock exposures is broken locally by faults. Erosion-resistant rocks cap mesas and buttes (BLM 2000a).

Topographic relief varies from moderate to steep slopes of canyons and mesas in the north-central and south-central portions of the Project Area, to rolling hills, cuestas, and gently sloping river valleys in the eastern and western portions of the Project Area. The central part of the SJB consists of a dissected plateau that dips gently to the west and deep, steep-sided canyons formed by streams within the basin (BLM 2000a). Elevations in the Project Area increase from south to north, and range from 6,000 feet to 9,000 feet above mean sea level.

The Project Area is drained to the south by the following tributaries of the San Juan River: the Animas River and its tributary, the Florida River; the Los Pinos (Pine) River; and the Piedra River. The San Juan River is a tributary of the Colorado River.

3.4.2.1.2 Concerns

The natural land surface is disturbed during development of CBM resources. Typically, sloping ground is leveled using cut-and-fill construction methods when roads, well pads, or other facilities are built. Topsoil is first stripped and conserved for use during reclamation. Then, underlying rock fragments and solid rock are excavated from cut slopes and pushed by heavy equipment to fill slopes, where the excavated material is spread to even out the topography of a site where a facility is to be constructed. Pipelines can be constructed across the sloping surface where slopes are not too steep without the use of extensive cuts and fills. The amount of cuts and fills necessary increases with slope for all types of facilities.

The pattern of naturally occurring landforms is altered wherever excavation occurs. The topography and characteristic landforms of an area affected by con-

struction would be restored during reclamation; however, restoration would be approximate because of the limitations of replacing "unbroken or in-place material" with loose material that takes up more space and may not hold the same form. Some modifications to the landscape may be necessary during reclamation to control future erosion or to facilitate revegetation of disturbed areas.

3.4.2.1.3 Effects of CBM Development to Date

CBM development has impacted the land surface of an estimated 570 acres to date within the Project Area. The existing disturbance is the result CBM and conventional gas well pads – 310 acres; access roads, pipelines, and utilities – 193 acres; injection well pads – 8 acres; and gas compression facilities – 12 acres. Approximately 85 acres of impacts were to BLM surface/BLM mineral estate and private surface/BLM mineral estate, and 75 acres of current CBM impact to San Juan National Forest. Impacts to landforms and physical landscapes may occur where construction takes place and would be most evident where slopes are steepest (and where cuts and fills would be largest). The impacts associated with landform disturbance are very minor and are discussed in more detail in the Visual Resources Section of this chapter.

3.4.2.2 Geology

3.4.2.2.1 Background

Structure and Geology

The SJB is an asymmetric basin about 200 miles long (north-south) and 130 miles wide (east-west) that is filled with sedimentary rocks. The deepest part of the basin, near the Colorado-New Mexico state line, is filled with up to 14,000 feet of sedimentary rocks (BLM 2000a). The Fruitland Formation is exposed near the margin of the basin in a series of outcrops that extend 90 miles across southwestern Colorado. Sedimentary rocks have been upturned in this area (BLM 2000a). The erosion of the Oligocene volcanic and volcaniclastic rocks over the upturned outcrop of the Fruitland Formation along the northern flank of the basin exposed the sandstones and coals of this formation (Laubach and Tremain 1994b). Fruitland coals are present throughout the subsurface of the basin to a maximum depth of slightly more than 4,000 feet (Fassett et al. 1997). The Animas and San Jose Formations that fill the SJB were formed by the deposition of sediments transported from the uplifted area to the north.

Minor folds occur throughout the basin and are especially apparent where the regional dip changes, such as near the Hogback monocline and at the periphery of the basin floor (Ayers et al. 1994). Natural fractures (joints and cleats) are widespread in Cretaceous and Tertiary rocks of the SJB (Laubach and Tremain 1994b) and consist of local fractures of tectonic origin and of fractures caused by compaction that occurred as coal formed (Ayers et al. 1994). The structural setting of the Project Area is described in Ayers and Kaiser (1994).

Local folds form structural traps for coal bed methane. Localized structural deformation caused fractures that may offset coal beds. Fractures that formed during folding may enhance coal bed permeability. These minor folds and faults caused fractures that may enhance the movement of water and gas through coal beds or may offset coal beds against rocks with lower permeability and impede

the movement of gas or water. Ayers and Zellers (1994) evaluate the impact of basin structures on the occurrence of coal bed methane.

Laubach and Tremain (1994a) describe fracture patterns in the northwestern portion of the SJB. Along the northwestern margin of the SJB, the west-northwest and northeast trends of fracture zones may coincide with permeability that is greater in the direction of cleat orientation than in other directions. Locally, prominent fractures in the Pictured Cliffs Sandstone extend into overlying Fruitland coal seams, where they are marked by more fractures with better interconnections and small normal faults. Permeability may be enhanced in these areas.

Structural features expressed in the Cretaceous strata that could affect movement of water or gas were considered in the 3M CBM model (Questa 2000) when their existence could be demonstrated by evidence or inferred by multiple reasons. No structural features were added to Questa's model in the Project Area. Structural features occurring outside the Project Area, including the Valencia Canyon and 44 Canyon faults southwest of Durango, may compartmentalize coal reservoirs near the northwestern margin of the basin and impede movement of water and gas (Ayers and Kaiser 1994, Applied Hydrology Associates 2000).

The only basement fault shown in the Project Area, which exhibits a surface trace of about 6 miles occurring along a west-northwest trend near Bayfield (Taylor and Huffman 1998), is not expressed in Cretaceous strata and therefore is not relevant to this analysis. Other regional geology maps do not show any faults in the Project Area (Steven et al. 1974, Green 1992, Van Loenen et al. 1997, Day et al. 1999). The locations where drainages cut through the Hogback monocline may represent the surface traces of faults. These locations include the Los Pinos River, Animas River, Florida River, Texas Creek, and Piedra River. However, published geologic maps, such as Fassett et al. (1997) which examine methane seep areas along some of these drainages in detail, do not show any mapped faults.

Unconsolidated surficial deposits (Quaternary deposits) overlie bedrock in some areas. Bedrock consists of layers of consolidated sedimentary rocks that form Cenozoic- and Mesozoic-age geologic formations. Geologic formations are sequences of rock layers that are recognizable over large areas. Depositional environments for the Cenozoic and Mesozoic formations described below included deep to shoreline marine environments and mostly fluvial continental environments. The rock types (lithology) associated with Cenozoic- and Mesozoic-age geologic formations occurring in the Project Area are described by Green (1992), Carroll et al. (1999), and Wray (2000).

The descriptions of these layers (stratigraphy) are summarized below. Formations are listed from youngest to oldest by their formal name. Geologic ages of the formations are shown in parentheses. Figure 3–12 shows the surface geology of the Project Area. A stratigraphic column for the NSJB is shown on Figure 3–13.

Cenozoic Era – Surficial deposits and geologic formations deposited from the present to sixty five million years ago.

Quaternary Deposits – These unconsolidated rock grains and clasts (rocks) were deposited during the last 1.8 million years before the present (CGS 2001). The grain or clast sizes and geologic processes characteristically associated with surficial deposits in the Project Area are listed below. Most types of surficial deposits occurring in the Project Area are poorly sorted by grain or clast size. Surficial deposits include the following types of unconsolidated deposits:

Alluvial – silt, sand, gravel, and cobbles deposited by steams and rivers in channels, fans, terraces, or floodplains;

Colluvial – clay, silt, sand, gravel, or cobbles deposited downslope by gradual gravity movement or sheetwash;

Landslide – clay, silt, sand, gravel, cobbles, boulders, rock debris, or rock masses deposited downslope by movement that can be sudden or continuous and slow;

Glacial – clay, silt, sand, gravel, cobbles, or boulders deposited by moving or melting glaciers;

Eolian – ash, clay, silt, or sand deposited by wind as loess (wind-blown soil) or sand dunes; and

Lacustrine – ash, clay, or silt deposited in lakes.

Tertiary Formations – These geologic formations were deposited between about two and sixty five million years ago.

San Jose Formation (Eocene) – This stratigraphic sequence is of fluvial origin and consists of interbedded siltstone, light sandstone, and dark varicolored shales. Sandstones are arkosic (contain the mineral feldspar) and massive. This formation generally overlies the Nacimiento Formation.

Nacimiento Formation (Paleocene) – This unit consists of interbedded dark shales and light sandstones that were deposited by meandering rivers along a braided alluvial plain. Sandstones are arkosic. The Nacimiento Formation is not exposed within the Project Area, but does contain fossils where it occurs in the central SJB.

Animas Formation (Paleocene and Upper Cretaceous) – This stratigraphic sequence of fluvial origin consists of gray-green to reddish brown sandstone, shale, and conglomerate that contain abundant volcanic materials, including tuffaceous (ash) interbeds, grains, and clasts. This unit also contains abundant petrified wood.

Mesozoic Era – Generalized listing of geologic formations deposited between 65 and 248 million years ago.

Kirtland Shale (Upper Cretaceous) – This formation is of fluvial origin and has three members: an upper shale member that consists of interbedded sandy shale and light sandstone; the middle Farmington Sandstone member that consists of light sandstone with interbedded siltstone and shale; and a lower shale member that consists of dark gray shale and lenses of dark sandstone.

Fruitland Formation (Upper Cretaceous) – This formation was deposited in a swampy coastal plain environment and consists of interbedded sandstone, shale, coal, and altered volcanic ash. The upper part of the sequence contains fluvial sandstones and shales. The lower part consists predominantly of sandstone, coal beds, and shale. Coal beds (seams) are prevalent in the basal part of the formation.

Pictured Cliffs Sandstone (Upper Cretaceous) – This formation was deposited in a shallow marine environment and consists of an upper thick, massive, light sandstone that overlies light sandstones and siltstones interbedded with dark shales. The Pictured Cliffs Sandstone locally intertongues with the Fruitland Formation.

Lewis Shale (Upper Cretaceous) – This formation was deposited in a low-energy offshore marine environment and consists of a thick sequence of dark gray fissile (flaky) shale that contains sandstone interbeds in the upper part that are potentially gas-bearing, and basal limestone. This formation also contains clay-rich altered volcanic ash beds.

Mesaverde Group (Upper Cretaceous) – This sequence consists of three formations grouped together, including the Cliff House Sandstone, the Menefee Formation, and the Point Lookout Sandstone. These formations are distinguished primarily by the presence of coal beds found only within the Menefee Formation.

Cliff House Sandstone (Upper Cretaceous) – This formation was deposited in a shallow marine environment and consists of light calcareous (contains calcium carbonate) sandstone interbedded with shale and mudstone that weathers to form rusty-colored outcrops.

Menefee Formation (Upper Cretaceous) – This formation was deposited in a coastal plain environment and consists of gray, brownish, and tan sandstone interbedded with dark, carbonaceous shales and coal beds. Locally, this formation contains burned rock and clinker that resulted from burning of coal beds.

Point Lookout Sandstone (Upper Cretaceous) – This formation was deposited in a coastal shoreline environment and consists of a massive upper sandstone with minor shale interbeds and a lower sequence of interbedded thin sandstone and shale beds.

Mancos Shale (Upper Cretaceous) – Most of this sequence was deposited in a low-energy marine environment. The basal part of the sequence was deposited in a near-shore environment. This formation consists of interbedded dark shales, silty shales, clayey to sandy limestones, limey sandstones, and bentonite (clay) beds. Thin bentonite beds occur throughout, but are most abundant in the basal part of the formation. The basal part of the formation also is calcareous and includes the Greenhorn Limestone member.

Dakota Sandstone (Upper Cretaceous) – This formation is mostly fluvial in origin but becomes increasingly marine in origin toward the top of the sequence. High-energy fluvial deposits occur near the base of the sequence. The formation consists predominantly of fine-

grained brown sandstones with carbonaceous shale partings and siltstones near the top of the sequence. Lower in the sequence, sandstones are interbedded with mudstones, carbonaceous shales, and thin coal beds. Channel sandstones with some conglomeratic beds occur near the base of the sequence.

Burro Canyon Formation (Lower Cretaceous) – This formation was deposited in a high-energy fluvial environment and consists predominantly of coarse-grained light sandstone and conglomeratic sandstone.

Morrison Formation (Upper Jurassic) – This formation is of continental fluvial and lacustrine origin. Greenish gray to reddish brown mudstone and claystone are dominant rock types in the upper part of the sequence. The lower part of the sequence contains light sandstone with thin interbeds of greenish gray mudstone. Bentonite beds also occur.

Bluff Sandstone (Middle to Upper Jurassic) – This formation is of continental origin and consists of a light-colored, crossbedded to massive eolian sandstone. It is correlative with the Junction Creek Sandstone.

Wanakah Formation (Middle Jurassic) – This sequence was deposited in a marginal marine and coastal plain environment. It consists of interbedded light to reddish colored sandstones and darker mudstones in the upper portion of the sequence and a medium to dark gray limestone in the lower portion.

Entrada Sandstone (Middle Jurassic) – This formation was deposited on an arid coastal plain and consists of light gray to orangish gray sandstone that typically contains prominent large-scale cross bedding.

Dolores Formation (Upper Triassic) – This formation was deposited in continental fluvial and lacustrine environments. It consists of an interbedded sequence of dark reddish shale and siltstone, sandstone, limestone pebble conglomerate, and rare thin limestone beds. It is correlative with portions of the Chinle Group (Moss Back Formation).

Paleozoic – age sequences are unlikely to be affected by development of CBM resources. The deepest formations that may be affected by development of CBM would be Mesozoic units that underlie the Fruitland Formation and contain zones where produced water could be injected. The oldest formation that has been used for injection within the Project Area is the Middle Jurassic Entrada Sandstone (COGCC 2002a).

3.4.2.2.2 Concerns

Surface geology consists of the pattern of naturally occurring rock outcrops and surficial deposits in an area. Naturally occurring outcrops and deposits would be altered wherever surface exposures are excavated. The stratigraphy, structure, and contacts between geologic units in the Project Area would not be changed, however.

3.4.2.2.3 Effects of CBM Development to Date

Development of CBM to date in the SJB has altered naturally occurring rock outcrops and deposits where surface exposures have been excavated to construct roads, drilling locations, or facilities. The stratigraphy, structure, and geologic contacts in the Project Area have not been affected.

3.4.2.3 Paleontologic Resources

3.4.2.3.1 Background

Paleontologic resources (fossils) constitute a fragile and nonrenewable scientific record of the history of life on earth. The BLM and FS have applied agency requirements to ground-disturbing activities to protect paleontologic resources and the scientific values they contain. Avoidance of significant sites is the preferred mitigation for adverse effects to paleontologic resources.

Several formations in the Project Area may contain significant fossil resources. Table 3-7 shows known fossil resources by geologic unit within the BLM's San Juan Resource Area, which includes the NSJB and the Project Area. These findings can be extrapolated to national forest.

Table 3-7 Paleontologic Resources of the San Juan Resource Area

Major Geologic Units	Known Fossil Resources
Quaternary Alluvium	Shrub Ox
San Jose Formation	Diverse early Eocene vertebrate fossils along the eastern margin of the SJB
Nacimiento Formation	Brachiopods; fish, crocodiles, turtles, various mammals, and temperate flora in central SJB, outside Project Area
Animas Formation	59 species of fossil plants, consisting of 3 ferns, 1 palm, 55 dicots; various vertebrates including *Triceratops*, *Discoscaphites*, and *Sphenodiscus*; abundant petrified wood; typical late-Paleocene mammalian fossils
Kirtland Shale	Baculites; various vertebrates, invertebrates, and plants in western SJB
Fruitland Formation	Baculites, vertebrates including dinosaurs; various vertebrates, invertebrates, and plants in western SJB
Pictured Cliffs Sandstone	Ammonites, cephalopods, baculites, ophiomorpha burrows, palm fronds, leaf impressions, petrified and carbonized palm wood
Lewis Shale	Ammonites, baculites, partial skeleton of a mosasaur, *Exiteloceras*
Mesaverde Group, undivided	Theropod dinosaur tracks, baculites, scaphites
Cliff House Sandstone	Ammonites, crustaceans, clams, oysters, snails, starfish, sea urchins, shark teeth, amphibians, turtles, mosasaur, plesiosaur
Menefee Formation	Leaf impressions, palm fronds, conifers, reptile bones, fossil tree trunk
Point Lookout Sandstone	Worms, crustaceans, clams, ammonites, various animal tracks, driftwood

Adapted from: BLM et al. 2000, Carroll et al. 1999, Kues and Lucas 1987.

3.4.2.3.2 Concerns

Paleontologic resources, once disturbed, lose much of their preserved information. Although fossils are rarely one of a kind, a limited number of specimens are preserved in any geologic formation. These resources cannot be used for scientific study if they have been damaged, destroyed, or removed without proper scientific documentation. The greatest potential for impact to surface and subsurface fossils would come from excavation of surface deposits or bedrock. Both surface and subsurface fossils could be damaged or destroyed during ground-disturbing activities. Ground-disturbing activities could result in a loss of resources or scientific values unless field survey is used to document, and remove for study where necessary, any significant paleontologic resources that could be affected.

3.4.2.3.3 Effects of CBM Development to Date

CBM development to date is not known to have damaged or destroyed significant paleontologic resources. The BLM and FS require surveys of all areas where ground-disturbing activity is proposed when significant paleontologic resources are known to occur. Lease provisions and APD conditions of approval require protection and prompt reporting of paleontologic resources discovered during project activities. Operations must be suspended until an evaluation that addresses discovery and mitigation is completed. In addition to potential adverse impacts during construction, significant fossils may become exposed during subsequent erosion of freshly excavated rocks. The agencies may recommend post-excavation paleontologic inspections, depending on the results of any pre-construction site survey.

3.4.2.4 Coal and Other Mineral Resources

3.4.2.4.1 Background

Mineral and energy resources that occur in the Project Area include oil, natural gas, coal, geothermal resources, sand, and gravel. The SJB of Colorado and New Mexico is the second-largest natural gas field in the United States. Since 1951, development of natural gas has been an important factor in local economies. CBM development in the SJB accelerated during the mid-1980s and has continued to the present. CBM is currently the primary focus of natural gas development in the SJB. Several coal mines that are inactive or abandoned are located within the Project Area. In addition, thermal springs occur within the Project Area. Finally, several active sand and gravel operations are located within the Project Area.

3.4.2.4.2 Conventional Oil and Gas Exploration and Development

The Ignacio-Blanco field, which produces from the Dakota Sandstone, Fruitland Formation, Pictured Cliffs Sandstone, and the Mesaverde Group, was discovered in 1950. The Dakota Sandstone, Mesaverde Group, and Pictured Cliffs Sandstone are the principal producing horizons and typically yield dry gas with small quantities of produced water and associated hydrocarbon liquids (BLM et al. 2000). By 1995, the Dakota Sandstone had produced 279 bcf of gas. Production from the Dakota Sandstone reached its peak in 1996, but this formation may still have potential for limited development. The Mesaverde Group produced 678 bcf of gas and 40,000 barrels of condensate from 1952 to 1995. Wells completed in the

Pictured Cliffs Sandstone, which includes the Pictured Cliffs Sandstone and Fruitland Sand, produced 88 bcf through 1995 (BLM et al. 2000).

As of December 2001, 13 active conventional gas wells exist in the Project Area within the Ignacio-Blanco field. Figure 3–12 shows the locations of the conventional wells within the Project Area (listed as Existing Non-Fruitland Wells). Existing conventional gas wells are all located on private mineral estate.

Coal Bed Methane

CBM is a by-product of the evolution of plants into coal. The influence of heating and pressure when organic debris is buried beneath thousands of feet of sediments causes CBM and coal to form. CBM is contained in and adsorbed to the coal until the pressure within the coal bed is reduced by removing groundwater, liberating CBM.

CBM occurs where the coal bed serves as both the source rock and the storage reservoir for methane gas. Methane is the primary component in CBM that is produced from the SJB; however, water, carbon dioxide, wet gasses (such as ethane, propane, and butane), nitrogen, and liquid hydrocarbons are also present in smaller quantities (BLM et al. 2000). Coal beds found within the Fruitland Formation are considered the most significant reservoirs for development of CBM within the SJB. The Menefee Formation also contains coals that may yield CBM, but only limited production has been recorded when compared with the Fruitland Formation (BLM et al. 2000).

Estimates for in-place CBM resources within the SJB include 50 trillion standard cubic feet (tcf) in the Fruitland Formation and 34 tcf in the Menefee Formation (BLM et al. 2000). Production from the Fruitland Formation to date (2000) exceeds 6 tcf when the New Mexico portion of the SJB is included (BLM et al. 2000).

The first CBM wells in the SJB were drilled into the Fruitland and Menefee Formations in 1948, and production was first recorded in 1951. Until the mid-1980s, inadequate technology for extraction of coal gas and the lower heating value (BTU) made CBM from the Fruitland Formation uneconomical to develop (BLM et al. 2000). Widespread CBM development began in the mid-1980s, after the Crude Oil Windfall Profits Tax provided tax incentives for operators to overcome technical problems associated with production of CBM (BLM et al. 2000).

Approximately 1,000 CBM wells were drilled in the Colorado portion of the SJB by 1999, including new wells and conventional gas wells plugged and recompleted in the coal beds of the Fruitland Formation, under COGCC Spacing Order No. 112–61. The order specifies a well spacing of 320 acres (BLM et al. 2000). Figure 3–12 shows the locations of all existing CBM wells in the Project Area. As of December 2002, approximately 310 active or approved CBM wells target the Fruitland Formation in the Project Area. CBM-produced water is injected at five disposal wells located on private land in the Project Area (COGCC 2002a). Two other disposal wells are classified as shut in (COGCC 2002a).

Coal

Coal is found within the Dakota Sandstone, Menefee Formation, and Fruitland Formation within the Project Area. The Menefee and Fruitland Formations contain the only coal beds that are thick enough to be considered viable resources in the NSJB. The Dakota Sandstone coals are thin, discontinuous, and have high ash content (BLM et al. 2000). Some very thin coal beds also have been noted in water wells completed within the Animas Formation (COGCC 2000a).

In the past, coal mining was much more important in the NSJB than it is today. Most coal has been produced from the Menefee Formation, with a small portion of production from the Fruitland Formation. Historical coal production was almost exclusively from underground mining, with the exception of two surface mines that have been inactive since the late 1980s (Carbon Junction Strip Mine and Chimney Rock Mine).

No active coal mines are located within the Project Area. Inactive or abandoned coal mines located in the Project Area are shown on Figure 3–12. The Carbon Junction Strip Mine, located along the outcrop of the Fruitland Formation east of Durango (Figure 3–12), produced 21,000 tons of coal from the Fruitland Formation before mining was terminated in 1988 (Carroll et al. 1999). The Chimney Rock Coal Mine located in the southeastern portion of the Project Area has been inactive since 1985. The operating permits for the Chimney Rock Coal Mine were terminated in 1999 (Colorado Division of Minerals and Geology [CDMG] 2002). Chimney Rock has been undergoing reclamation since 1985 and in 2002 was in its final year of reclamation that began in 1991 (Koblitz 2002).

Outside the Project Area, coals in the Fruitland Formation are strip mined at the La Plata Mine in the New Mexico portion of the SJB. A few small, private mines also are operating along the outcrop of the Fruitland Formation and Hogback monocline in the SUIT Reservation (Lawson 1998). The Menefee Formation was being actively mined as of January 2002 at the underground King Coal Mine, located west of the Project Area (CDMG 2002).

Geothermal Resources

Most geothermal resources in Colorado are low temperature. Geothermal resources that occur in the Project Area and surrounding areas consist of warm water emanating from springs or wells. Most warm springs are located near faults that serve as conduits for upward flow of groundwater that has been heated by circulation deep below the surface (Trautner et al. 2001).

Several warm springs surface along the valley margins of the Animas River. Trimble Hot Springs and Pinkerton Hot Springs, located north of the Project Area along the Animas River, are commercially and industrially developed for bathing and space heating (Barrett and Pearl 1976, Geo-heat Center 2002). Flow at Trimble Hot Springs is a few gallons per minute (gpm). The resort is served by a shallow well pumping about 260 gpm. TDS range from about 1,600 to 3,300 mg/L. Reported temperatures range from 90 to 124 °F (Trautner et al. 2001).

Hickerson Hot Spring is located outside the Project Area along the valley margin of the Animas River in Section 10, T. 35 N., R. 9 W. (Carroll et al. 1999, Traut-

ner et al. 2001). This spring issues from a pipe in an opening to an old mine within a limestone layer near the base of the Wanakah Formation (Carroll et al. 1999) or possibly from the Entrada Sandstone or overlying Pony Express Limestone (BLM et al. 2002). Potential impacts to the Hickerson Hot Springs from produced water injection were reported in the BLM Whitepaper on CBM Development (BLM 2000a), but the report concluded that no definitive correlation exists. The report described decreasing water temperatures and quantity at the Hickerson Hot Springs until produced water injection into the Entrada Sandstone ceased in 1999 at a well site nine miles to the south.

Sand, Gravel, and Aggregate

Sand and gravel are typically found in floodplain and terrace deposits along rivers and streams. Many well-indurated rocks are well suited for use as aggregate when crushed. Clinker (burned coal and surrounding rock) frequently is used as aggregate. Sand, gravel, and aggregate are surface mined, primarily for use in construction and road maintenance. Active sand, gravel, and aggregate mines in the Project Area are shown on Figure 3–12.

3.4.2.4.3 Concerns

Mineral and energy resources are non-renewable and occur in limited locations. Conflicts with development of these resources might reduce their availability or cause an economic impact. The potential for conflict or coordinated development exists where economically important coal and CBM resources are found in the same area.

The injection of CBM produced water into disposal wells could affect the quality, quantity, or temperature of geothermal wells or springs within the area of influence for the disposal well. Conditions at geothermal wells or springs can change miles from a disposal well for CBM produced water.

3.4.2.4.4 Effects of CBM Development to Date

An estimated 1,676 bcf of CBM have been produced from 1,248 wells in the Colorado portion of the SJB through 1998 (Questa 2000). This production represents an estimated 8.6 percent of the in-place reserves of CBM within the SJB.

To date, no impacts to coal mines or sand, gravel, or aggregate mining operations located within the Project Area have been attributed to development of CBM resources.

In 1989, a disposal (injection) well located nearly 9 miles south of Hickerson Hot Spring began injecting water into the Entrada Sandstone, the unit just below the Wanakah Formation (BLM 2000a). The injection pressure at the well was increased in 1993 to drive the water (BLM 2000a; Trautner et al. 2001). In 1997, the spring's owners reported that the flow rate and temperature of the spring had increased over the last 5 years and that the water had become too hot for customary household use (BLM et al. 2002). Temperatures as high as 133°F and flows to 65 gpm were documented at that time (BLM et al. 2002). Chemical analyses indicate an increase in sodium and sulfate content as compared with a 1970 test (BLM 2000a).

Injection into the Entrada Sandstone stopped in January 1999, based on test results from the disposal well and other uncertainties regarding the well that were addressed by COGCC, EPA, and the CBM operator. The water temperature of Hickerson Hot Spring declined from 132 or 133°F (observed between December 1997 and January 1999) to 127 F by August 1999 (BLM et al. 2002). The flow rate decreased to 49 gpm, the lowest observed since monitoring began in November 1997. The changes observed at the Hickerson Hot Springs occurred immediately after injection was terminated at a disposal well located nearly 9 miles away.

3.4.2.5 Landslides and Slope Stability

3.4.2.5.1 Background

Landslides are slow or rapid downslope movements of rock and surficial deposits that are common throughout Colorado, including in the Project Area (CGS 1998). The landscape is altered by these events, which have many causes and forms. The types of landslides found in the Project Area include rockfalls, rockslides, rotational slumps (in both soil and rock), earth flows, mud and debris flows, and shallow soil slips. The landslides result from a combination of factors, including mountainous terrain, rock type and composition, weakening of the rock from weathering, orientation of the geologic structure relative to ground slope, and groundwater conditions.

The landslide hazard in most of the Project Area is low. However, where steeper slopes occur, such as near the Hogback monocline and in the HD Mountains of the SJNF, the U.S. Geological Survey (USGS), CGS, and FS have mapped numerous landslides. Landslides mapped by these agencies within or adjacent to the Project Area are shown on Figure 3–14.

The landslides near the Hogback monocline mostly occur in the Fruitland Formation, with some movement of the overlying Kirkland Shale. An example located near the Project Area is the "Moving Mountain" slide just south of Durango. Newspaper accounts from 1932 indicate that this landslide was associated with explosions. The movement of the slide followed the outcrop of the Fruitland Formation along one limb of the steeply dipping hogback. Several of these landslides, including Moving Mountain, started as rockslides, transitioned into debris flows as they moved down the hillside, and formed depositional debris fans where the slope flattened.

The mapped landslides within the Project Area are in the Animas and San Jose Formations as well as some of the slides described previously near the Hogback monocline. Shale layers are interbedded with more resistant sandstone in both the Animas and the San Jose Formations. The Animas Formation also contains layers of volcanic ash. These shale and ash layers weather quickly and form surfaces of weakness that contribute to landslide formation, particularly where the sedimentary bedding surfaces are approximately parallel to ground that is moderately or steeply sloping.

Landslides also occur in the San Jose and Animas Formations where the orientation of the bedding is close to horizontal. For example, landslides within the Project Area have developed in colluvium below cliffs formed by the massive sand-

stone of the San Jose Formation. Rockfall, rockslides, and debris avalanches increase the weight of material at the top of the slopes below the cliffs, resulting in large, deep-seated landslides of unconsolidated material moving over weathered sandstone and shale. Most of the slopes in the HD Mountains below steep slopes or cliffs of the San Jose Formation were formed by landslides, although subsequent weathering and erosion have obscured some of the characteristic features.

Shallow translational landslides that transition into mud and debris flows are common on steeper slopes that are underlain by the San Jose and Animas Formations. Many of the mapped landslides exhibit fresh cracks in the ground, sparsely vegetated scarps, and leaning trees that indicate recent movement. Nearby slopes with similar geologic and topographic characteristics are potentially unstable and could be destabilized with disturbance or an increase in precipitation. Based on a FS analysis of landslides mapped by the USGS and CGS, slopes steeper than 40 percent that are underlain by the San Jose Formation and slopes steeper than 30 percent that are underlain by the Animas or Fruitland Formations or the Kirkland Shale are classified as areas of high landslide hazard.

There are also areas of high landslide hazard that occur on BLM administered lands and BLM split estate as depicted on Figure 3–14.

3.4.2.5.2 Concerns

Road, pipeline, and well pad construction can cause new or renewed movement of landslides. Prevention of human-induced mass movement depends, in part, on avoiding additional disturbance to existing landslides and areas susceptible to movement. Landslides could damage the environment and CBM facilities. Adverse environmental effects could then result from damaged CBM facilities.

3.4.2.5.3 Effects of CBM Development to Date

To date, no increased movement of existing landslides or development of new landslides within the Project Area has been attributed to CBM development. Almost all of the previous development has occurred in areas of low landslide hazard.

3.4.2.6 Subsurface Geologic Stability and Water Injection

3.4.2.6.1 Background

Geologic stability of the subsurface considers the potential effects of earthquakes in the Project Area and the risk that earthquakes could be caused by CBM development.

Earthquake Hazards

Colorado is considered a region of minor earthquake activity; the southwestern corner of the state, which is part of the stable Colorado plateau, has experienced no fault activity in historical times (USGS 2001). The nearest notable faults that are potentially active occur more than 155 miles from the Project Area.

A moderate (5.5 magnitude) earthquake in 1996 centered in Dulce, New Mexico, was the closest significant earthquake to the Project Area and was felt throughout

much of southern Colorado. Other minor earthquakes that caused little or no felt effects or damage have occurred within 155 miles of the Project Area (Kirkham and Rogers 2000). A few epicenters of earthquakes with magnitudes that measured 5.9 and lower have been located in La Plata and Archuleta Counties (CGS 1999).

Risk of Earthquakes Caused by Underground Injection

EPA has regulated underground injection (and by some states on behalf of EPA) since 1974, when the SDWA was enacted. Regulation minimizes the risks associated with disposal (injection) wells by controlling the spacing of injection wells and the volume of fluids injected. Thus, fluids can enter the rock formation without causing an excessive buildup of pressure or fracturing rocks that could cause an earthquake. Until 1974, controls on injection wells were inadequate. Many examples exist of environmental impacts that resulted from fracturing of rock layers or release of built-up pressure caused by injection. However, there have been no known occurrences of earthquakes induced by injection of CBM-produced water in the SJB.

One well-known example of earthquakes that were associated with a disposal well near an active fault is from during the 1960s in the Denver, Colorado, area. A 12,000-foot injection well was drilled at the Rocky Mountain Arsenal in 1961, and injection began in 1962. Between 1962 and 1968, a large number of earthquakes of moderate magnitudes occurred, some causing significant damage. The largest earthquakes, magnitude 5.0, 5.2, and 5.3 tremors, occurred in 1967. Fluid was removed from the injection well in 1968. No significant earthquakes were recorded after fluid had been removed from the injection well (CGS 1999, Kirkham and Rogers 2000).

3.4.2.6.2 Concerns

No linkage has been established between CBM development in the SJB and a risk of earthquakes caused by injection of produced water. EPA regulations are designed to control injection so that there is no buildup of pressure from injected fluids that could cause an earthquake if the pressure were released suddenly.

3.4.2.6.3 Effects of CBM Development to Date

Earthquakes occurring in Colorado since about 1962 (prior to the beginning of CBM development) have been recorded by seismographs (USGS 2001). There have been no recorded occurrences of earthquakes induced by injection of CBM produced water in the Project Area. No evidence has been found to date that links CBM development in the SJB with a risk of earthquakes caused by injection of CBM-produced water.

3.4.2.7 Subsurface Geologic Stability and Water Extraction

3.4.2.7.1 Background

Subsidence has been associated with compression of aquifers (Galloway et al. 1999, Case et al. 2000) and with compression of unconsolidated layers (Galloway et al. 1999). Consolidation occurs over time as the forces of gravity act on the sediments that have been deposited. During consolidation, water is expelled

and the sediments are compacted into consolidated rock. The water expelled during consolidation is often referred to as the "water of compaction." Case et al. (2000) describe the potential for minor aquifer compression and subsidence to occur in consolidated rocks because of planned development of CBM in the Powder River Basin (PRB) of Wyoming, a structural basin that contains a thick sequence of sedimentary rocks.

Galloway et al. (1999) describe land subsidence in the United States, including land subsidence that results from compaction of aquifer systems when groundwater is removed. Land subsidence is a gradual settling or sudden sinking of the earth's surface. Unconsolidated aquifer systems that contain a sufficient thickness of fine-grained sediments (silts and clays) are susceptible to compaction and subsidence. The compaction of aquifer systems is a principal cause of more than 80 percent of the subsidence that has been identified in the United States.

Pore space is lost when large-scale drawdown of an unconsolidated aquifer occurs for the first time. The aquifer system is compacted as pore fluid is squeezed out of the surrounding fine-grained sediments and into the aquifers (Galloway et al. 1999).

Galloway et al. (1999) correlate long-term declines in groundwater levels and land subsidence with the release of the water of compaction from compacting layers. "Long-term groundwater level declines can result in a vast one-time release of 'water of compaction' from compacting aquitards that manifests itself as land subsidence. This 'water of compaction' cannot be reinstated by allowing water levels to recover to their predevelopment status. The reduction of fluid pressure in the pores and cracks of aquifer systems, especially in unconsolidated rocks, is inevitably accompanied by some deformation of the aquifer system.

"…Almost all the permanent subsidence occurs due to the irreversible compression or consolidation of aquitards. …In confined aquifer systems the volume of water derived from irreversible aquifer compaction is essentially equal to the volume of subsidence and can typically range from 10 to 30 percent of the total volume of water pumped. …Seasonal displacements in land surface of up to one inch are in response to the seasonal changes in groundwater pumpage."

Significant ground subsidence has occurred where unconsolidated alluvial aquifers have become compressed through dewatering. In the United States, subsidence of the ground surface related to withdrawal of fluid has been documented at a number of localities, including the San Joaquin Valley in California and the Las Vegas area in Nevada (Galloway et al. 1999). The areas share a common geological tie in that they are underlain by saturated, unconsolidated sands and gravels with interbeds or overlying beds of saturated clays. Water removed from the aquifer by pumping caused ground subsidence.

As noted, Case et al. (2000) describe conditions in the PRB of Wyoming, a structural basin that contains a thick sequence of consolidated sedimentary rocks. The SJB is also a structural basin that contains a thick sequence of consolidated sedimentary rocks. Like the Fort Union Formation in the PRB, the Fruitland Formation in the SJB is a consolidated rock unit and is being only partially dewatered.

The bedrock that underlies the surface is compacted and consolidated. Instead of loose sand, sandstone is present; instead of unconsolidated clay, shale is present.

A formula used by Case et al. (2000) to calculate the amount of aquifer compression in the PRB requires a value for change in head (drawdown). In the PRB, pre-development water levels in water wells have been incorporated into a three-dimensional groundwater flow model with aquifer characteristics, geologic cross sections, topography and surface drainages, production data, and monitoring data for water levels from ongoing development of coal and CBM. This complex groundwater model addresses water production, regional flow, and leakage among aquifer units, and has been used to project drawdown of static water levels in wells that could be anticipated based on planned development of CBM. Existing aquifer compression in the NSJB cannot be calculated in the manner presented by Case et al. (2000) since a three-dimensional groundwater flow model that could be used to project drawdown has not been developed for the NSJB.

Case et al. (2000) found that minor aquifer compression up to ½ inch could occur near Gillette, Wyoming, where nearly 6,000 CBM wells in the PRB develop much thicker coals and produce much more water. Aquifer compression that has resulted from CBM development to date in the NSJB (310 wells) likely would be much less than would be expected from development of nearly 6,000 wells in the PRB, or much less than ½ inch.

3.4.2.7.2 Concerns

Removal of groundwater has the potential to cause noticeable subsidence in some geologic settings; however, the setting of the Fruitland Formation in the SJB is not conducive to noticeable aquifer compression. Galloway et al. (1999) report that seasonal fluctuations in displacement of the land surface of up to 1 inch can occur in response to seasonal changes in groundwater pumpage. The potential compression that could be associated with CBM development in the NSJB likely would be much less than the ½ inch that Case et al. (2000) projected for the PRB. Furthermore, it would not be noticeable in comparison with seasonal displacements of the land surface noted by Galloway et al. (1999).

3.4.2.7.3 Effects of CBM Development to Date

No evidence to date has been found that ground subsidence has resulted from production of CBM and water from the Ignacio Blanco Field (BLM et al. 2000). In addition, no noticeable or measurable aquifer compression or ground subsidence has been observed in the NSJB to date. Development of CBM in the NSJB to date is not associated with a risk of noticeable aquifer compression or ground subsidence.

3.4.2.8 Subsurface Geologic Stability and Hydraulic Fracturing/Cavitation

3.4.2.8.1 Background

Small fractures are generated during well completion by hydraulic fracturing when the producing formation immediately surrounding the CBM well bore does not contain enough natural cleats or fractures to facilitate movement of gas to-

ward the CBM well. In hydraulic fracturing, tiny sand grains, aluminum pellets, glass beads, or similar materials are carried in suspension by pressurized water and are forced out into the formation through perforations in the well's production casing. Only a limited area surrounding the CBM well bore is affected by this activity. Hydraulic fracturing is designed not to disrupt the structural integrity of the coal seam or the surrounding formations.

COGCC and BLM requirements for well drilling procedures ensure that each formation remains as isolated as it is under natural conditions and that the integrity of the well bore stays intact. The enlarged well bore in open-hole completions that use cavitation completion methods is designed not to disrupt the structural integrity of the coal seam or the surrounding formations, since production of CBM depends on the integrity of the cleats (the system of small fractures that occur naturally in the coal).

3.4.2.8.2 Concerns

No link between the use of cavitation or hydraulic fracturing to complete CBM wells and the stability of subsurface formations has been established.

3.4.2.8.3 Effects of CBM Development to Date

No effects on geologic stability have been attributed to the use of hydraulic fracturing or cavitation completion methods during CBM development.

3.4.2.9 Coal Fires

3.4.2.9.1 Background

Coal fires often occur naturally where coal beds are exposed at the surface or lie at shallow depths. The fires can be ignited by events such as lightning strikes, campfires, and even spontaneous combustion. The surface temperature at coal fires can become high enough to generate plumes of steam in cold weather (several hundred degrees Fahrenheit). Pungent odors and high levels of carbon monoxide and sulfur dioxide often emanate from the location of the plumes. Only small amounts of methane gas are vented to the atmosphere, however, because of consumption during the combustion process (BLM et al. 2000).

No coal outcrop fires have been identified within the Project Area (BLM et al. 2000, Keller 2001). Five active coal fires have been identified in the NSJB, all within the western portion of the SUIT Reservation, south of the Project Area.

Historically, self-heating of near-surface coals has resulted in fires on coal outcrops in the region. Wildfires have been linked to two known coal fires and may ignite sub-surface coals (BLM 2000a). These two coal fires are located in areas of recent wildfires, suggesting that surface flames may have followed tree roots into the soil, igniting sub-surface coals. Conversely, the burning coal can ignite a wildfire when underground coal fires break out on the land surface and continue burning above ground. Evidence from one coal fire indicates a possible linkage between dewatering of coal seams and resurgence of coal fires (BLM 2000a).

Seasonal fluctuations in the water table or lowering the water table in the coal beds because of CBM development exposes coals to oxygen, causing oxidation to occur and releasing heat. The exposure of dry coals to moisture also produces

heat. It is virtually impossible to establish whether self-heating of near-surface coal affected the ignition or resurgence of current coal fires near the Project Area (BLM 2000a).

Water levels are currently monitored at 28 sites along the coal outcrop, within and near the western portion of the SUIT Reservation. Measurements of water levels will identify areas that may be affected by increased occurrences of coal fires through continued or expanded gas and water production from the coals (BLM et al. 2000).

3.4.2.9.2 Concerns

Fires in coal outcrops could be induced or exacerbated by CBM development, causing the loss of coal resources and creating aggregate (clinker) resources. Coal outcrop fires could start surface wildfires, and could lead to subsidence and landslides. It is not clear whether activities associated with CBM development have induced or exacerbated existing coal bed fires.

Dewatering of coal seams as part of CBM development may be linked to coal bed fires (BLM 2000a). Lowering the water table could draw ambient air into coal beds, supplying oxygen to support combustion. Fluctuating water levels in coal beds can trigger heating and supply oxygen that may cause spontaneous combustion (BLM 2000a).

3.4.2.9.3 Effects of CBM Development to Date

It is unknown whether CBM production has played a significant role in inducing or exacerbating coal fires in the NSJB. Evidence from one coal fire indicates a possible linkage between dewatering of coal seams and a resurgence of coal fires (BLM 2000a).

3.4.3 Environmental Consequences

3.4.3.1 Landforms/Physical Landscapes

The impacts associated with landform disturbance are very minor and are discussed in more detail in the Visual Resources Section of this chapter.

3.4.3.2 Geology

Implementation of Alternative 1 and any other of the alternatives would alter naturally occurring outcrops and deposits whenever surface exposures are excavated. The stratigraphy, structure, and contacts between geologic units would not be affected, however.

3.4.3.3 Paleontological Resources

3.4.3.3.1 Alternative 1 — Proposed Action

CBM development could affect paleontological resources where associated excavation disturbs the geologic formations identified as fossil-containing strata. This disturbance would occur at or near outcrops of these formations. Little of the Project Area on any jurisdiction has been inventoried for the presence of paleon-

tological resources. As a result, the number of paleontological sites that may be affected cannot be accurately estimated.

Paleontological resources contained in near-surface horizons of soil and surficial deposits likely already have been disturbed by natural processes or human activity. Surface use and shallow excavations likely would have little or no effect on paleontological resources that occur just below the surface.

As part of the APD approval process for federal leases, BLM and the FS require a survey of all areas where ground-disturbing activity is proposed when significant paleontological resources are known to occur. APD conditions of approval require protection and prompt reporting of paleontological resources that are discovered during the project. Operations must be suspended until the discovery is evaluated and mitigation measures implemented.

All facilities located on federal surface ownership lands would be considered federal undertakings, and thus would be subject to federal guidelines and regulations that protect paleontological resources. No federal permits are required for lands where oil or gas development excludes federal leases or surface ownership lands, however, and protection measures for paleontological resources might not be mandated by the landowners or be monitored as closely. Therefore the potential for disturbance or destruction of paleontological resources on private land is greater than on federal jurisdiction where mitigation would be utilized if paleontological resources were discovered.

3.4.3.3.2 Alternative 2

A total of 230 additional well pads (114 on national forest and 10 on BLM) would be developed under this alternative compared with Alternative 1. Alternative 2 would increase road mileage by about 85 miles on all jurisdictions (55 miles on national forest and 3 miles on BLM) compared with Alternative 1. As a result, there would be a greater potential for paleontological resource damage during surface-disturbing activities on all jurisdictions. Mitigation measures described in Section 3.4.5 would be utilized to minimize disturbance or destruction of paleontological resources on FS and BLM administered lands if discovered

3.4.3.3.3 Alternative 5 — No Action

Under Alternative 5, additional development of federal leases would not be authorized at this time. Thus the potential for paleontological impacts on federal jurisdiction would be the lowest among the alternatives. Potential paleontological impacts on private and state land would be essentially the same as Alternative 1 but lower than Alternative 2.

3.4.3.3.4 Alternative 6

Because 104 fewer well pads would be developed under this alternative on federal jurisdiction (103 less on national forest and 1 less on BLM) as compared to Alternative 1, there would be less potential for paleontological resource damage during surface-disturbing activities on federal jurisdiction. This alternative would also decrease the number of miles of new roads by nearly 51 miles on national forest, compared with Alternative 1. Mitigation measures described in Section

3.4.5 would be utilized to minimize disturbance or destruction of paleontological resources on Forest Service and BLM administered lands if discovered.

On state and private jurisdiction, potential impacts to paleontological resources would be as described for Alternative 1.

3.4.3.3.5 Alternative 7

Alternative 7 would approve 35 fewer well pads and 26 less miles of road than Alternative 1 in three zones within the SJNF — HD Mountains (Ignacio Creek, the area south of the Rock Bridge and area south of the Relay Tower). Therefore, the potential for impacting paleontological resources would be commensurately less than Alternative 1 as a result of Alternative 7. Mitigation measures described in Section 3.4.5 would be utilized to minimize disturbance or destruction of paleontological resources on FS and BLM administered lands if discovered.

On state and private jurisdiction, potential impacts to paleontological resources would be as described for Alternative 1.

3.4.3.4 Coal and Other Mineral Resources

3.4.3.4.1 Alternative 1 — Proposed Action

CBM development is not expected to impact coal mining because no active coal mines operate in the Project Area. Conflicts between CBM drilling and potential coal mining could occur, although there are no known plans for future coal mining on any jurisdiction within the Project Area. Locating wells in areas where future mining may take place would preclude mining during the life of CBM wells located in the area proposed for mining. Coal in these areas could be mined after CBM extraction is completed or terminated, or after an agreement is negotiated between the CBM developers and the coal mine operators.

Development of non-CBM oil and gas resources likely would not noticeably affect CBM development nor would CBM development noticeably affect development of non-CBM oil and gas resources on any jurisdiction within the Project Area. Development of other producing zones would be compatible and may share some facilities, such as roads, pipelines, or utilities. Collateral use of some facilities would minimize surface disturbance and use of construction materials for both activities.

The NSJB contains reserves of other mineral resources. The most common in the Project Area are sand, gravel, and aggregate. These resources are also nonrenewable and can be exhausted. Development of CBM could interfere with the potential recovery of these other mineral resources. Development could remove an estimated 1 to 3 acres of land from mineable mineral reserves for each well that would be located within an area that could be surface mined. Mining likely could not occur near wellheads, injection wells, pipelines, or utilities without damaging oil or gas production facilities.

3.4.3.4.2 Alternative 2

Impacts to coal and other mineral resources would be similar to the effects described under Alternative 1.

3.4.3.4.3 Alternative 5 — No Action

Drainage of federal CBM resources likely would be increased as a result of Alternative 5, where only new non-federal CBM wells likely would be drilled.

3.4.3.4.4 Alternative 6

Impacts to coal and other mineral resources would be similar to the effects described under Alternative 1.

3.4.3.4.5 Alternative 7

Impacts to coal and other mineral resources would be similar to the effects described under Alternative 1.

3.4.3.5 Landslides and Slope Stability

3.4.3.5.1 Alternative 1 — Proposed Action

Project Area

Surface disturbance could exacerbate existing landslides and cause new landslide hazards in the Project Area. Mass movements would likely increase within the Project Area, causing damage to resources and property unless disturbance to existing landslides and areas susceptible to movement, such as steep slopes or unstable soils, is avoided or mitigated during gas development. Landslides could be activated during development; however, design of operations that incorporate best management practices and mitigation measures that minimize the risk of landslides would reduce the potential that landslides would increase within the Project Area.

All facilities located on federal surface ownership lands would be considered federal undertakings, subject to federal guidelines and regulations for environmental protection. No federal permits are required where development of CBM excludes federal leases or surface ownership lands, and protection measures for geologic hazards might not be mandated by the landowners or monitored as closely.

Siting characteristics related to geologic hazards, such as landslide areas and slope hazard areas, are summarized on Table 3-8 for proposed wells, well pads, roads, and pipelines on all jurisdiction under Alternative 1. Most of the Alternative 1 facility construction disturbance would take place in areas of low topographical relief and, consequently, low risk of landslides. Based on 262 well pads proposed on all jurisdictions under Alternative 1, 9 well pads would occur in landslide areas. About 5 miles of proposed roads out of 118 total miles of proposed roads under Alternative 1 would affect landslide areas. About 1 mile of proposed pipeline under Alternative 1 would affect landslide areas. The areas where most landslides have been mapped are on the SJNF in the HD Mountains and on or near the steeply dipping Hogback monocline along the northern and northeastern boundary of the Project Area. The Hogback monocline along the northeastern boundary is also part of the HD Mountains.

Table 3-8 Geologic Hazards Siting Summary by Alternative and Jurisdiction for Proposed Wells, Well Pads, and Roads

	Siting Characteristics		
Facility	Within Landslide Areas	Within Slope Hazard Areas – Animas and Fruitland Formations and Kirtland Shale with Slopes Greater than 30 Percent	Within Slope Hazard Areas – San Jose Formation with Slopes Greater than 40 Percent
Project Area			
Alternative 1			
Number of Wells	12	10	3
Number of Well Pads	9	10	2
Miles of Roads	5	6	6
Miles of Pipeline	1	0	0
Alternative 2			
Number of Wells	21	45	14
Number of Well Pads	18	45	14
Miles of Roads	9	19	12
Miles of Pipeline	1	0	0
Alternative 5			
Number of Wells	0	6	0
Number of Well Pads	0	6	0
Miles of Roads	0	3	0
Miles of Pipeline	0	0	0
Alternative 6			
Number of Wells	1	8	0
Number of Well Pads	1	8	0
Miles of Roads	0	3	1
Miles of Pipeline	0.0	0	0
Alternative 7			
Number of Wells	2	10	3
Number of Well Pads	2	10	2
Miles of Roads	1	6	2
Miles of Pipeline	0	0	0
National Forest			
Alternative 1			
Number of Wells	12	1	3
Number of Well Pads	9	1	2
Miles of Roads	5	4	6
Miles of Pipeline	1	0	0
Alternative 2			
Number of Wells	19	17	3
Number of Well Pads	16	17	2
Miles of Roads	9	12	12
Miles of Pipeline	1	0	0
Alternative 5			
Number of Wells	0	0	3
Number of Well Pads	0	0	2
Miles of Roads	0	1	0

Table 3-8 Geologic Hazards Siting Summary by Alternative and Jurisdiction for Proposed Wells, Well Pads, and Roads

	Siting Characteristics		
Facility	Within Landslide Areas	Within Slope Hazard Areas – Animas and Fruitland Formations and Kirtland Shale with Slopes Greater than 30 Percent	Within Slope Hazard Areas – San Jose Formation with Slopes Greater than 40 Percent
Miles of Pipeline	0	0	0
Alternative 6			
Number of Wells	1	0	3
Number of Well Pads	1	0	2
Miles of Roads	0	2	1
Miles of Pipeline	0	0	0
Alternative 7			
Number of Wells	2	1	3
Number of Well Pads	2	1	2
Miles of Roads	1	4	2
Miles of Pipeline	0	0	0
BLM			
Alternative 1			
Number of Wells	0	6	0
Number of Well Pads	0	6	0
Miles of Roads	0	1	0
Miles of Pipeline	0	0	0
Alternative 2			
Number of Wells	0	13	0
Number of Well Pads	0	13	0
Miles of Roads	0	3	0
Miles of Pipeline	0	0	0
Alternative 5			
Number of Wells	0	1	0
Number of Well Pads	0	1	0
Miles of Roads	0	0	0
Miles of Pipeline	0	0	0
Alternative 6			
Number of Wells	0	5	0
Number of Well Pads	0	5	0
Miles of Roads	0	1	0
Miles of Pipeline	0	0	0
Alternative 7			
Number of Wells	0	6	0
Number of Well Pads	0	6	0
Miles of Roads	0	1	0
Miles of Pipeline	0	0	0

Alternative 1 does not include well pads or access roads closer than 1 mile to the crest of the Hogback anticline within La Plata County. Because the dip of the

sedimentary rock formations and the ground slope become less steep south of the crest, Alternative 1 would not increase the risk of human-induced landslides from road or well pad construction near the Hogback monocline within La Plata County. Well pads and access roads on the SJNF within Archuleta County are proposed as close as 0.3 miles from the steeply dipping Hogback monocline. Construction of these facilities would create some risk of triggering new or increasing the movement of existing landslides.

Based on 284 wells proposed on 261 well pads under Alternative 1, 10 wells located on 10 well pads would occur in slope hazard areas in the Animas and Fruitland Formations and Kirtland Shale with slopes greater than 30 percent, and 3 wells located on 2 well pads would occur in slope hazard areas associated with the San Jose Formation and slopes greater than 40 percent (Table 3-8). About 12 miles of proposed roads out of 118 total miles of proposed roads under Alternative 1 would affect slope hazard as identified on Table 3-8. No miles of proposed pipeline under Alternative 1 would affect slope hazard areas.

National Forest

Within the SJNF — HD Mountains (Table 3-8), construction of well pads and access roads would increase the risk of human-induced landslides. A total of 9 well pads and 5 miles of road would be constructed in existing landslide areas.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the upper and lower Ignacio Creek area, 5 well pads, 3 miles of new roads, and approximately 0.2 miles of new pipelines would cross existing landslide areas, and 2 miles of new roads would cross slope hazard areas (Table 3-8).

The principal access road to lower Ignacio Creek crosses an existing landslide area that based on field reconnaissance, displays considerable instability and thus a tendency for new road construction to result in mass wasting. Construction of the access road across Section 29U, T34N, R5W would require geotechnical engineering that addresses substantive concerns about stable road construction, continuous road use for a period of 30 years, and stable rehabilitation following plugging and abandonment of the wells the road would access.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Rock Bridge, 1 well pad, 0.2 miles of new roads, and 0.5 miles of new pipelines would cross landslide areas, and less than 1 mile of new roads and 0.2 miles of new pipelines would cross slope hazard areas. Accessing the area south of the Rock Bridge, across the Rock Bridge itself would present a engineering challenge that has not been met to date Filed reconnaissance of the rock bridge road location suggests that a road cannot be safely constructed without significant grades to proposed wells to the south. Further filed reconnaissance of alternative access routes is needed.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Relay Tower, no well pads, 0.7 miles of new roads, and less than 0.2 miles of new pipelines would cross landslide areas, and 0.7 miles of new roads and 0.4 miles of new pipelines would cross slope hazard areas. The existing Relay Tower road has continuously displayed localized areas of mass wasting and other signs of instability that would require road reconstruc-

tion that incorporates geotechnical approaches to stability. The extension of the Relay Tower road to access well sites to the south would follow a route that crosses through landslide hazard areas that may display the same inherent instability as the current road. Because of route instability, this road would be difficult to construct, maintain, and rehabilitate following plugging and abandonment of wells.

BLM Lands

No roads or well pads would be constructed in existing landslide areas. A total of one mile of road and six well pads would be constructed in slope hazard areas that constitute slopes greater than 30 percent in the Kirtland shale.

The most effective mitigation measure for construction on unstable slopes is avoidance. Modifications of the preliminary proposed road and well pad locations may allow avoidance of some landslide areas and potentially unstable slopes. However, the limitations imposed by grade requirements and other design criteria would likely result in less than full avoidance, with additional landslides and potentially unstable slopes being affected by construction and some subsequent slope failures. The extent of increased landslide activity is impossible to predict precisely. However, the proposed miles of new road construction in areas of high hazard is a good numerical indicator for comparison of alternatives.

Extensive field investigation and design can support stable road construction across most slopes within the HD Mountains. Where increased movement of existing landslides and initiation of some new landslides occur, the consequences would include visible scars on hillsides, disturbance of vegetation, erosion, and potential damage to roads, pipelines, and well pads.

3.4.3.5.2 Alternative 2

Project Area

Siting characteristics related to geologic hazards, such as landslide areas and slope hazard areas, are summarized on Table 3-8 for proposed wells, well pads, roads, and pipelines under Alternative 2. Alternative 2 would involve constructing 85 more miles of new access roads and 230 more well pads than Alternative 1 (114 more well pads on national forest and 10 more pads on BLM). About 77 well pads would be located in areas of landslide or slope hazards, compared with 21 well pads in these hazard areas under Alternative 1. Because most of the additional proposed wells would be located near the steeply dipping Hogback monocline or in the SJNF — HD Mountains where the landslide and slope hazards are greater, the potential extent and magnitude of landslides and associated damage would be greater than Alternative 1. Alternative 2 would result in 40 miles of new roads crossing areas of landslide or slope hazards compared with 17 miles of new roads crossing areas of landslide or slope hazards under Alternative 1.

Based on 491 proposed well pads under Alternative 2, 45 wells located on 45 well pads would occur in slope hazard areas in the Animas and Fruitland Formations and Kirtland Shale with slopes greater than 30 percent, and 15 wells located on 14 well pads would occur in slope hazard areas associated with the San Jose Formation and slopes greater than 40 percent (Table 3-8). About 31 miles of proposed roads out of 203 total miles of proposed roads under Alternative 2 would

affect slope hazard areas identified on Table 3-8. No miles of proposed pipeline under Alternative 2 would affect slope hazard areas.

National Forest

Within the SJNF — HD Mountains (Table 3-8), Alternative 2 construction of well pads and access roads would increase the risk of human-induced landslides when compared to Alternative 1. A total of 16 well pads and nine miles of road would be constructed across existing landslide areas.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the upper and lower Ignacio Creek area, 5 well pads, 3 miles of new roads, and 0.2 miles of new pipelines would cross landslide areas, and 2 miles of new roads would cross slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Rock Bridge, 1 well pad, 0.2 miles of new roads, and 0.5 miles of new pipelines would cross landslide areas, and less than 1 mile of new roads and 0.2 miles of new pipelines would cross slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Relay Tower, 1 well pad, 1.2 miles of new roads, and less than 0.2 miles of new pipelines would cross landslide areas, and less than 0.7 miles of new roads and less than 0.4 miles of new pipelines would cross slope hazard areas. Impacts resulting from accessing Ignacio Creek, the area south of the Rock Bridge and the area south of the Relay Tower would be as described for Alternative 1.

BLM Lands

No roads or well pads would be constructed in existing landslide areas. A total of three miles of road and 13 well pads would be constructed in slope hazard areas that constitute slopes greater than 30 percent in the Kirtland shale.

3.4.3.5.3 Alternative 5 — No Action

Project Area

Siting characteristics related to geologic hazards, such as landslide areas and slope hazard areas, are summarized on Table 3-8 for proposed wells, well pads, roads, and pipelines under Alternative 5. Alternative 5 would involve constructing 75 fewer miles of new roads and 144 fewer well pads than Alternative 1. Because many of the wells and roads that would be eliminated would have been located in the SJNF — HD Mountains, the extent and magnitude of the environmental consequences would be less than under Alternative 1.

Based on 117 wells proposed on 117 well pads under Alternative 5, six wells would occur in slope hazard areas in the Animas and Fruitland Formations and Kirtland Shale with slopes greater than 30 percent, and no wells or well pads would occur in slope hazard areas associated with the San Jose Formation and slopes greater than 40 percent (Table 3-8). About 3 miles of proposed roads out of 43 total miles of proposed roads under Alternative 5 would affect slope hazard areas identified on Table 3-8. No miles of proposed pipeline under Alternative 2 would affect slope hazard areas.

National Forest

Within the SJNF — HD Mountains (Table 3-8), construction of well pads and access roads to develop non-federal minerals under Alternative 5 would increase the risk of human-induced landslides. Overall, however, the potential impacts of Alternative 1 would be far less than for Alternative 1. One-tenth mile of road would be constructed over existing landslide areas to access split estate wells.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the upper and lower Ignacio Creek areas, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Rock Bridge, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Relay Tower, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Therefore, there would be no resultant road construction impact to these three areas as a result of Alternative 5 and the highly unstable or difficult access areas would be avoided.

BLM Lands

There would be no well pad or road construction over areas of existing slope hazard.

3.4.3.5.4 Alternative 6

Project Area

Alternative 6 would involve constructing 53 fewer miles of new roads and 85 fewer well pads than Alternative 1. Because many of the wells and roads that would be eliminated would have been located in the HD Mountains, the extent and magnitude of the environmental consequences would be less than under Alternative 1.

Based on 178 wells proposed on 176 well pads under Alternative 6, 8 wells located on 8 well pads would occur in slope hazard areas in the Animas and Fruitland Formations and Kirtland Shale with slopes greater than 30 percent, and no wells or well pads would occur in slope hazard areas associated with the San Jose Formation and slopes greater than 40 percent (Table 3-8). About 4 miles of proposed roads out of 65 total miles of proposed roads under Alternative 6 would affect slope hazard areas identified on Table 3-8. No miles of proposed pipeline under Alternative 6 would affect slope hazard areas. Therefore, there would be no resultant road construction impact to these three areas as a result of Alternative 6 and highly the highly unstable or difficult areas of access would be avoided

National Forest

Within the HD Mountains (Table 3-8), construction of well pads and access roads to develop federal and non-federal minerals under Alternative 6 would increase the risk of human-induced landslides. However, potential impacts would be less than described for Alternative 1 because of the limited development on the National Forest and the absence of development within the HD Mountains Roadless Area, which displays a high percentage of slope hazard area. Alternative 6 would result in development of ¼ mile of road and one well pad in existing

landslide areas and two miles of road and two well pads in high slope hazard areas.

Based on the preliminary location of proposed well pads, access roads, and pipelines in the upper and lower Ignacio Creek area, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Rock Bridge, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Based on the preliminary location of proposed well pads, access roads, and pipelines in the area south of the Relay Tower, no well pads, roads, or pipelines would cross landslide or slope hazard areas. Therefore, there would be no resultant road construction impact to these three areas as a result of Alternative 5 and highly the highly unstable or difficult areas of access would be avoided.

BLM Lands

Environmental consequences would be as described for Alternative 1.

3.4.3.5.5 Alternative 7

Project Area

Siting characteristics related to geologic hazards, such as landslide areas and slope hazard areas, are summarized on Table 3-8 for proposed wells, well pads, roads, and pipelines under Alternative 7. Alternative 7 would involve constructing 26 fewer miles of new roads and 35 fewer well pads than Alternative 1 because construction would not proceed in Ignacio Creek , the area south of the Rock Bridge and in the area south of the Relay Tower due to concerns about slope stability and geologic hazard.

Based on 237 wells proposed on 226 well pads under Alternative 7, 10 wells located on 10 well pads would occur in slope hazard areas in the Animas and Fruitland Formations and Kirtland Shale with slopes greater than 30 percent, and 3 wells located on 2 well pads would occur in slope hazard areas associated with the San Jose Formation and slopes greater than 40 percent (Table 3-8). About 8 miles of proposed roads out of 92 total miles of proposed roads under Alternative 7 would affect slope hazard areas identified on Table 3-8. No miles of proposed pipeline under Alternative 7 would affect slope hazard areas.

National Forest

Alternative 7 would result in development of one mile of road and two well pads in existing landslide areas and six miles of road and three well pads in high slope hazard areas.

Access roads would not be constructed to Ignacio Creek, the area south of the Rock Bridge, or to the area south of the Relay Tower road, thus avoiding construction in three areas considered to be highly unstable and/or difficult to construct stable roads. With avoidance of these three areas, the potential impacts of Alternative 7 would be less than that considered probable for Alternative 1 on National Forest.

BLM Lands

Environmental consequences of facility construction on BLM lands would be as described for Alternative 1

3.4.3.6 Subsurface Geologic Stability and Water Injection

3.4.3.6.1 All Alternatives, all Jurisdictions

No excessive buildup of pressure within rocks or fracturing of rocks would be anticipated to result from produced water injection. Therefore, no underground injection triggered earthquakes would be expected. Underground injection is and would be conducted in accordance with federal and state regulatory requirements. Injection wells would be authorized only where the injection zone is sufficiently porous and permeable that fluids could enter the rock formation without causing an excessive buildup of pressure or fracturing of rocks.

3.4.3.7 Subsurface Geologic Stability and Water Removal

3.4.3.7.1 All Alternatives, all Jurisdictions

Removal of water from the Fruitland coal seam would not likely cause noticeable ground subsidence or aquifer compression in the Project Area under any of the alternatives. Water would be extracted from the Fruitland Formation, which is a consolidated rock unit and, therefore, would not be susceptible to noticeable subsidence.

3.4.3.8 Subsurface Geologic Stability and Hydraulic Fracturing and Cavitation

Hydraulic fracturing and cavitation must maintain the integrity of the coal and surrounding formations to be effective. In addition, COGCC and BLM require conduct of these procedures in a manner that maintains the integrity of the formations. For these reasons, the stability of the subsurface geology would not be affected by any of the alternatives.

3.4.3.9 Coal Fires

3.4.3.9.1 All Alternatives, all Jurisdictions

Partial removal of water from the coal seam near the coal outcrop during CBM development depressurizes the coal seam and could create a condition where oxygen replaces water in the coal seam and increases the risk of spontaneous combustion. The risk of underground coal fires would be limited to the area where oxygen is available to sustain coal fires. Oxygen would be introduced to the shallow subsurface environment through conduits to the surface, such as well bores or naturally occurring fractures. Water pumped from the Fruitland coals miles away from the outcrop would affect the water levels and, consequently, the risk of coal fires near the outcrop. However, unless enough oxygen is able to reach the dewatered coals to sustain combustion, underground coal fires would not occur. The conditions affecting the availability of oxygen near the outcrop would not be expected to vary among the alternatives, provided proper well drilling and operation procedures are followed.

The risk of coal fires near the coal outcrop would be influenced by the extent and frequency of fractures or fissures that extend from the underground coal seams to the surface. In the NSJB these conduits likely would be most prevalent in areas near the outcrop where methane seepage is the greatest, as shown on Figure 3–3

There is a natural limit to the depth and distance from the outcrop at which underground coal fires can be sustained. This limit is based on the availability of oxygen underground to sustain the combustion of coals. Although this natural limit has not been described in the NSJB, the limits of coal fires away from the outcrop have been studied in other western coal basins.

Clinker and coal fires in the Powder River Basin in Wyoming have been studied by Heffern and Coates (1997), Coates and Heffern (1999), and Heffern and Coates (1999). As coal burns, the burn front advances into the hillside until, with increasing depth, fissures in deposits that overlie the coal fail to reach the surface. At that point, the supply of air to the coal is cut off, extinguishing the fire. Clinker can be found at depth by drilling as far as several hundred feet back from where it is apparent at the surface.

The risk of coal fires near the coal outcrop also could be proportional to the number of proposed wells that would be drilled near the outcrop. Drilling a conduit to the coal seam could increase the availability of oxygen. However, the conditions established and maintained in CBM wells during drilling and after completion to meet health and safety requirements and to optimize gas production also create unfavorable conditions for spontaneous combustion of coal. Well bore conditions are controlled to ensure airflow out of the well, to flush fines from the well, and to vent heat at the surface. Although the potential for coal fires could be increased by wells drilled near the outcrop, this potential risk would be mitigated by proper operation of the wells.

3.4.4 Cumulative Effects

The cumulative effects analysis for geology and minerals considered past and reasonably foreseeable actions in the Project Area and within the bounds of the Southern Ute Reservation where oil and gas development has and will continue to take place.

3.4.4.1 All Alternatives

The characteristic landforms of the surface geologic environment would be altered by reasonably foreseeable surface disturbing activities. The cumulative effects on the surface geologic environment would be minimized if proper techniques for well pad and facility siting, construction, and reclamation are used. Development projects would require restoration of disturbed lands and would minimize alterations to topography. Standard stipulations and project- and site-specific construction and reclamation procedures would be required for additional development on federal lands. These measures would further minimize cumulative impacts on the surface geologic environment, including existing landslide deposits and areas with high landslide risk. Although reasonably foreseeable actions would be unlikely to trigger geologic hazards such as landslides,

mudslides, debris flows, or slumps, an incremental increase in cumulative impacts associated with geologic hazards could occur.

Paleontological resources are non-renewable resources that can become exhausted. Although fossils are rarely one-of-a-kind, a limited number of specimens are preserved in any geologic formation and these cannot be used for scientific study, if damaged, destroyed, or removed without proper scientific documentation. The BLM, FS, and SUIT have applied mitigation measures to surface disturbing activities in the cumulative effects analysis area that would protect paleontological resources and the scientific values they contain. Cumulatively, anticipated development activities would not be expected to noticeably affect paleontological resources, provided the mitigation measures identified are implemented.

Across the cumulative effects area, slope stability concerns are as described for the Project Area. Wherever steep slopes and highly erosive soils are encountered, reasonably foreseeable future actions, such as CBM development, vegetation management, livestock grazing, wildfires, and prescribed burning, could cause an increase in slope failures and associated sedimentation and erosion. The probability of slope failures occurring outside the Project Area is unknown, but operators developing Southern Ute oil and gas leases generally utilize the same engineering standards and mitigation approaches described below to minimize slope failures. The same holds true for construction practices on private and state land. However, through not quantifiable, even if projects are well engineered and mitigation measures described earlier in this chapter are implemented, potentially unstable slopes subjected to the removal of vegetation or facility construction of drill pads, roads, or other facilities could fail. Unplanned actions such as wildfires, prolonged wet periods, or large storms could destroy vegetation or introduce excessive precipitation that would trigger slope movement.

Development of non-CBM oil and gas resources likely would not noticeably affect CBM development in the cumulative effects analysis area. Similarly, CBM development would not noticeably affect development of non-CBM oil and gas resources. These development activities would be compatible, and may share some facilities, such as roads, pipelines, or utilities. Collateral use of some facilities would minimize surface disturbance and the use of construction materials for both activities.

3.4.5 Mitigation and Monitoring

Several measures are presented to mitigate paleontological impacts, landslides, and slope stability concerns. Unless otherwise stated, the measures would be funded by the companies.

The impacts to paleontological resources would be mitigated on federal lands by measures incorporated in the APD conditions of approval that require protection and prompt reporting of paleontological resources that are discovered during the project. Operations must be suspended until the discovery is evaluated and mitigation measures are implemented.

It is unlikely that CBM wells would be located on an area with mineable sand, gravel, and aggregate resources. However, avoiding the areas where these mineable deposits occur would mitigate potential impacts to these other mineral resources.

Measures, to mitigate effects of the alternatives on landslides and slope stability include:

- Utilize engineering geologists or geotechnical engineers to conduct geotechnical engineering investigations for any facilities, including existing roads, proposed new roads, and well pads that require construction or reconstruction in or near areas that meet the criteria for high landslide hazard (see Section 3.4.2.5.1), or exhibit other instability features.
- Where possible, avoid landslides, unstable slopes, and other areas that exhibit instability features or meet the criteria for high landslide hazard during facility location, including well pads and roads.
- Where avoidance is not possible, the geotechnical engineer shall design stabilization measures to be approved by the appropriate agency and incorporated in construction or reconstruction plans. Possible stabilization measures include, but are not limited to, subsurface drainage, retaining walls, and soil reinforcement.

Avoidance of unstable sites is the most effective form of mitigation. Where sites cannot be avoided, geotechnical stabilization designs and practices are generally effective. However, the risk of landslides or other catastrophic failure cannot be completely eliminated and facility maintenance becomes more challenging and expensive. Reclamation of areas that have been heavily engineered also poses a challenge when compared to other areas that are otherwise stable. Operators would be required to provide financial surety in most instances (Appendix A) to cover the estimated third-party costs of reclamation activities necessary to return the landform to a stable, non-erosive, and revegetated condition when economic gas production ends.

3.4.6 Conformance to Existing Plans and Policies

Management standards and guidelines that address the issues presented and discussed in this section are described in the SJNF LRMP, Forest Direction for protection of soils, watershed, and visual quality. Adherence to professional engineering standards and geo-technical engineering design requirements, best management practices, and standards and guidelines for visual management will protect the geologic resources of the area and minimize erosion, mass wasting, and landslides that may scar the landscape and lead to other environmental impacts.

Paleontological resources will be protected by pre-construction surveys where there are known or stratified high probabilities for their occurrence.

3.4.7 Unavoidable Adverse Effects

The surface impacts associated with facility development would be an unavoidable adverse effect that would persist during the life of the project.

3.4.8 Irreversible and Irretrievable Effects

The extraction of mineral and energy resource commodities represents an irreversible and irretrievable commitment of the resources to development. As nonrenewable resources, once developed, the resources are consumed.

The surface disturbance associated with mineral and energy resource development or other reasonably foreseeable development activities could alter or destroy existing landforms. Some landforms may not be completely restored during reclamation. The alteration or loss of these features would be an irreversible and irretrievable commitment of the surface geologic environment.

The surface disturbance associated with the development of mineral and energy resources would commit the lands affected to a single purpose use for the life of the project, until existing uses, such as livestock forage or wildlife habitat and resource values, such as scenic quality, are restored during reclamation. Partial reclamation would be completed after construction activities and permanent reclamation would proceed at the end of the project. In some cases, prior soil productivity would not fully recover at some sites, representing an irretrievable commitment of resources. Soil productivity would only recover over a long period after development ends.

3.5 Groundwater Resources

The hydrogeologic framework of the Project Area is made up of large areas of low-yield aquifers throughout the region, with minor areas of higher-yield alluvial fill aquifers in the valley floors of the major rivers.

Deeper geologic formations are also aquifers, but have limited utility because of low yields, poor water quality, and uneconomic drilling depths. The following section describes the hydrostratigraphy in greater detail

3.5.1 Hydrostratigraphy

Groundwater occurs in all geologic formations within the Project Area. Table 3-9 summarizes the hydrostratigraphy in the Project Area.

Alluvial Aquifers – Alluvial deposits are not extensive within the Project Area; however, these aquifers are important to the groundwater cycle within the SJB. Quaternary and recent alluvial deposits consist of floodplain or terrace deposits.

Typically, these unconsolidated gravelly deposits are characterized by a thin saturated layer and are highly dependent on recharge from natural sources and return flows from irrigation. The groundwater resources that are contained in alluvial aquifers are under unconfined or water table conditions.

The alluvial aquifers consist of river valley aquifers and the Florida Mesa aquifers in densely populated southeast La Plata County. River valley aquifers consist of shallow, loose gravels and sands near rivers and streams and usually have a good sustained yield because of regular recharge from rivers. The Florida Mesa aquifers consist of thick gravel deposits situated over a large area.

Well yields from floodplain alluvial deposits typically range from 1 to 10 gpm in the La Plata and Animas River valleys. Deposits are thicker and the yields higher, ranging from 5 to 25 gpm, in the Piedra and Pine River valleys (Brogden et al. 1979). Terrace deposits are characteristically only partially saturated and well yields are generally 10 gpm or less; however, yields of 50 gpm have been reported (Brogden et al. 1979; Robson and Wright 1995). Currently, no known landslide or eolian deposits are used as sources of water (Kernodle 1996).

Bedrock Aquifers – Bedrock aquifers in the SJB are within the Colorado Plateaus aquifer system described by Robson and Banta (1995). Three major aquifers could be affected by CBM development. From shallowest to deepest, these aquifers are the Uinta-Animas, Mesaverde, and Dakota-Glen Canyon. The Uinta-Animas aquifer includes Tertiary units within the San Jose, Nacimiento, and Animas Formations. The Mesaverde aquifer includes Upper Cretaceous units within the Mesaverde Group. The Dakota-Glen Canyon aquifer includes Cretaceous and Jurassic units within the Dakota Sandstone, Burro Canyon Formation, Morrison Formation, Wanakah Formation, and Entrada Sandstone.

Table 3-9 Hydrologic Characteristics of Developed Aquifer Units in the Northern San Juan Basin

Age	Unit	Thickness (feet)	Physical Character	Hydrologic Characteristics	Water Quantity and Water Use
Quaternary	Floodplain Deposits	50	Unconsolidated clay, silt, sand, gravel, and boulders. Generally poorly sorted and confined to present day stream valleys. Includes low- level terraces, alluvial fans, and eolian material.	Hydraulic conductivity: ~ 0.006 to 220 ft/d, Typical Porosity: ~ 20-35%, Specific yield: ~ 0.1 to 0.25.	Average well yield is 15 gpm with maximum yield of 25 gpm reported. Water is generally used for domestic and livestock purposes and, where suitable, for drinking water.
	Terrace Deposits	100	Clay, silt, gravel, and boulders. Sediments are poorly sorted, with coarser materials being well rounded. Includes higher-level stream valleys and terraces, eolian materials, and remnants of alluvial fans.	Hydraulic conductivity: ~ 0.006 to 220 ft/d, Typical Porosity: ~ 20-35%, Specific yield: ~ 0.1 to 0.25.	Average well yield ranges from 5 to 10 gpm with maximum yield of up to 50 gpm reported. Water is generally used for domestic and livestock purposes.
Tertiary	San Jose Formation	250–2400	Interbedded sandstone, siltstone, variegated shale, and conglomerate. Sandstones are arkosic and massive and are interbedded with red, maroon, and gray shales.	Transmissivity: 40 to 120 ft^2/d, Hydraulic conductivity: < 10-3 ft/d, Typical Porosity: ~ 3-30%.	Well yields range from 5 to 61 gpm with an average yield of 5 gpm. Water is generally used for domestic and livestock purposes, with a few natural gas compression and transmission plants using the water.
	Nacimiento Formation	0–50	Sandstone and shale. Sandstones are arkosic, white, medium to coarse grained, and are interbedded with black and gray shale. Note: Formation grades laterally into the Animas	No Data	No known wells within the Project Area
Upper Cretaceous	Animas Formation	230–2700	Varicolored shale, with interbedded breccia, conglomerate, and tuffaceous sandstone. Diagnostic characteristic is the macroscopic volcanics. The sandstone varies from light to rusty brown to purple, and contains abundant silicified wood and clay balls.	Transmissivity: ~40 to 120 ft^2/d, Hydraulic conductivity: < 10-3 ft/d, Typical Porosity: ~ 3-30%, Specific Capacity: 0.24 to 2.30 gpm/ft drawdown. Note: Artesian wells are present in areas where sandstones are overlain by impermeable shales.	Well yields range up to 75 gpm (50 gpm near Durango) with an average yield of 6 to 7.5 gpm. Water is generally used for domestic and livestock purposes.

Tertiary aquifers typically consist of sandstone interbedded with shale units and are exposed at the land surface, or are overlain and potentially hydraulically connected to alluvial aquifers. Potable water from bedrock aquifers in the Project Area is most commonly found in the San Jose, Nacimiento, and Animas Formations.

The Animas Formation is the best Tertiary aquifer in the area, with well yields of 50 gpm near Durango and 75 gpm in the southern portion of the Project Area. The mean yield for wells completed in the Animas Formation is between 6 and 7.5 gpm. Water yields from the San Jose Formation have been found to vary between 15 and 61 gpm, with a mean yield of 5 gpm (Kernodle 1996).

The Fruitland Formation is a regional aquifer with low water yields (Cox et al. 2001). This aquifer is regionally interconnected despite the presence of fracturing and internal stratigraphic units that are not continuous. The Fruitland Formation is not classified as a principal aquifer within the SJB (Robson and Banta 1995).

Usable water is commonly present in a number of formations near the margins of the basin where older formations occur at shallower depths, closer to areas recharged with fresh water. Cretaceous-age formations that contain usable water near the margins of the SJB include the Farmington Sandstone member of the Kirtland Shale, the Fruitland Formation, the Pictured Cliffs Sandstone, formations of the Mesaverde Group, including the Cliff House Sandstone and the Point Lookout Sandstone, and the Dakota Sandstone.

Thick confining units that are almost impermeable and generally do not yield water include the Mancos Shale and the Lewis Shale, although isolated siltstones and sandstones in these formations have been found to produce small amounts of water locally. Thinner confining units that consist of shale that is slightly more permeable, as well as coal and thin sandstone beds, are present in the Menefee Formation, Fruitland Formation, and the lower and upper shale members of the Kirtland Shale. Unusable water is present in deep sandstones within the basin (Kernodle 1996, AHA 2000, Questa 2000, BLM et al. 2000).

In general, the water supply from Cretaceous and older aquifers is minimal (less than 5 gpm), although moderate quantities (5 to 25 gpm) may be supplied from aquifers within the Menefee Formation, Mancos Shale, Dakota Sandstone, Burro Canyon Formation, and Morrison Formation (Aiken et al. 2000). The Cretaceous aquifers are typically under confining conditions as a result of the presence of thick impermeable units that overlie and underlie the aquifers.

The most widely exploited aquifers in the Project Area are the shallow sandstone units of the Animas Formation, the San Jose Formation, and the Quaternary Alluvium deposits. The bedrock aquifers are low-yield, low-transmissivity units that typically supply 0.5 to 5 gpm to domestic wells. Useable amounts of groundwater occur in the channel-fill sands of the San Jose and the Animas Formations, with lesser volumes produced from the mudstones surrounding these sandstone bodies. The sandstones are confined.

The alluvial fill aquifers are associated with the major river valleys that cross the Project Area, and on the Florida Mesa. These aquifers are unconfined and typi-

cally supply 10 to 25 gpm to water wells. Alluvial fill in the river valleys varies greatly in thickness, with some well logs showing less than 8 feet to more than 90 feet of unconsolidated gravel, cobbles, and boulders overlying the bedrock. The Florida Mesa is covered by unconsolidated sand, gravel, and cobbles, and this aquifer is also unconfined. Use of groundwater from the alluvial fill aquifers and the shallow bedrock aquifers is increasing in La Plata County. Changes in land uses in the county have trended toward a higher density of domestic wells and a gradual shift from agricultural to rural residential. Because agriculture in the Project Area was a primary source of groundwater recharge through irrigation returns, the reduction in agriculture use directly reduces the recharge to shallow aquifers. Increasing the density of domestic wells also increases the withdrawals from these shallow aquifers. As demand for groundwater rises and recharge diminishes, the aquifers in La Plata County will be gradually depleted. These depletions are not associated with CBM development, however. Figure 3–15 illustrates the density of shallow domestic water wells in the Project Area.

As is evident from Figure 3–15, the number of domestic wells in La Plata County is growing at a fast rate. The number of water-well permits issued in the Project Area has averaged more than 300 per year for the past 10 years. The resulting additional stress on the shallow groundwater resources will accelerate depletion of shallow aquifers.

The deeper geologic formations that are considered aquifers include the Fruitland Formation and Pictured Cliffs Sandstone, the Point Lookout and Cliff House sandstones of the Mesaverde Group, and the Dakota Sandstone. Of these, the Fruitland Formation/Pictured Cliffs Sandstone aquifer is the only aquifer that is exploited for groundwater in the Project Area. These two formations form a single hydrostratigraphic unit, confined above by the Kirtland Shale and below by the Lewis Shale. The Pictured Cliffs Sandstone is interconnected in some areas with the Fruitland Formation; therefore, they can be considered a single aquifer. In some areas, the Fruitland Formation appears to be hydraulically isolated from the Pictured Cliffs Sandstone, either through an intervening shale layer, or because the permeability in the Pictured Cliffs is so low that the majority of groundwater flow is conducted through the higher-permeability Fruitland Formation.

3.5.2 Hydrogeology of Fruitland Formation

The following discussions and assessments of the groundwater system and impacts related to CBM development are BLM and FS interpretation of field data, published papers, and projections made by the 3M Model (Questa 2000) and the work by Cox et al. (2001).

It should be noted that Riese et al. (2005) present a different viewpoint about the characteristics and operation of the groundwater system and impacts of CBM development. Their conclusions are presented in Section 3.3.6 (Methane Seeps).

The Fruitland Formation and Pictured Cliffs Sandstone are unconfined at the outcrop, where they are recharged. The aquifer is confined several hundred meters downdip and throughout the San Juan Basin, where the overlying Kirtland Shale acts as an aquitard and confining unit. In several areas, water wells drilled just

down dip of the outcrop through less than 100 feet of Kirtland Shale are artesian, meaning that less than 100 feet of shale provides an effective seal over the aquifer in the Fruitland Formation.

As discussed in the methane seepage section (Section 3.3), the Kirtland Shale is an effective confining unit, which seals the Fruitland Formation from overlying shallow aquifers.

Flow of groundwater in the Fruitland Formation occurs primarily in the higher-permeability coal beds. Although coal beds are not laterally continuous across the entire Project Area, they are sufficiently interconnected to allow the Fruitland Formation to act as a single aquifer system. Flow within the Pictured Cliffs Sandstone appears to occur in fracture zones (secondary permeability) and in some areas of higher primary permeability.

The following is a summary of literature on the Fruitland Formation hydrogeology:

McCord et al. (1992) interpreted higher temperature gradients in the Fruitland Formation to indicate that advection is transporting heat from the northern rim of the basin to the deeper basin. This heat transport was interpreted based on temperature logs from numerous wells. The temperature gradient increased across the Fruitland Formation in all the wells. The source of heat was interpreted to be the igneous intrusions of the San Juan Mountains, north of the basin. McCord (1988) also produced a potentiometric surface map of the Fruitland Formation in Colorado (Figure 3–16).

Other workers, including Fassett and Hinds (1971), have interpreted the heat of the San Juan intrusive complex to be the cause of higher thermal maturity in coals from the Fruitland Formation in the northernmost San Juan Basin. The thermal maturity cannot be explained solely by the burial depth of the coals; therefore, an additional source of heat was required to explain the high thermal maturity.

Berry (1957 and 1959) provided a basin-wide potentiometric surface map of the Fruitland Formation, along with general flow patterns of groundwater. His map is based on hundreds of pressure measurements in the Fruitland Formation, collected before any CBM development began (Figure 3–17). The Gas Research Institute (GRI 1990) published a potentiometric map of the Fruitland Formation that shows a similar pattern of potentiometric contours when compared with the work of Berry, McCord, and others (Figure 3–18).

Kernodle et al. (1990) also interpreted the Fruitland Formation as a regional aquifer, with flow fed by recharge at the outcrop and discharge occurring at river cuts along the rim of the basin.

Oldaker (1987 and 1991) published potentiometric contour maps of the Fruitland Formation and interpreted a similar pattern in the potentiometric contours when compared with McCord, Berry, and others. Oldaker's interpreted flow patterns are consistent with McCord et al. (1992), Berry (1957 and 1959), GRI (1990), and others.

CGS published an open file report in 1980 that illustrated the coal content as a percent of the total thickness in the Fruitland Formation. The coal content exceeds 20 percent of the gross thickness of the Fruitland Formation in large portions of the NSJB. Fogg (1986, 1987, and 1990) illustrated that formations with more than 20 percent sand body content act as a single flow system, with cross-communication among many of the stratigraphically separate sand bodies. The coals in the Fruitland Formation are higher-permeability units and likely act similar to the sand bodies in Fogg's work (1986, 1987, and 1990), transporting fluid in a similar manner. The 20 percent aggregate thickness of higher-permeability material seems a reasonable cutoff for most aquifer and hydrocarbon systems.

In 1999, COGCC, BLM, and the SUIT commissioned the 3M Project. This study was focused on evaluating the impacts of CBM development on methane seepage at the outcrop of the Fruitland Formation. As part of the study, CGS published a series of cross sections that illustrated the continuity of many coal beds across several miles of the basin. These cross sections, coupled with previous work by CGS, illustrate the overall regional hydraulic continuity of the Fruitland coals.

Further evidence of hydraulic continuity can be extracted from a report by Burlington Resources. Burlington Resources recently completed a comprehensive survey of stratigraphic picks on 46 correlatable tops from the major formations and time stratigraphic markers found in the SJB. This project involved more than 2-years of work and was completed by Geological Data Services of Dallas, Texas.

About 20,000 well bores are included in this data set, encompassing 240 townships. Included in the report is documentation of any subsurface faulting found during the study. Faults were identified by checking anomalies shown on a complete series of isopach and structural maps generated with tops from the well data file.

Of this extremely large data set, only 127 wells out of 20,000 scattered across the basin showed any evidence of fault displacement in the Cretaceous sections. Almost all of these faults can be found within a 46-township area in the northwest and a 68-township area in the southeast of the basin. The southeastern block, which contains the majority of the faults, averages about 1.5 faults per township. The northwestern block that contains the Valencia Canyon area averages only one fault for every two townships.

This study effectively eliminates a dense network of small-scale sealing faults that compartmentalize the reservoir. Instead, it indicates that coal beds remain interconnected and capable of actively transporting groundwater.

As summarized above, a large body of peer-reviewed published literature supports the conclusion that the Fruitland Formation is a regional confined aquifer system.

3.5.3 Other Supporting Information

3.5.3.1 Bulk chemistry — Major Ions

Chlorine, bicarbonate, and other major ions exhibit a consistent pattern in the groundwater from the Fruitland Formation, with lower concentrations near the recharge areas and progressively higher concentrations in the deeper basin. This gradient in concentration is consistent with Toth's (1972) explanation of the geochemical evolution of groundwater:

- Contents of dissolved minerals are known to increase with the water's subsurface residence time. Consequently, the mineral content of groundwater is expected to be relatively low at shallow depths of the recharge areas and in short, active systems.
- Conversely, TDS would be high at great depths in discharge areas and in extensive, sluggish systems.

Other studies support this basic underpinning of hydrogeochemistry, including Garrels (1960) and many others.

Mapping of the bulk chemistry of groundwater from the Fruitland Formation illustrates that several near-outcrop regions of low TDS are likely to be much younger groundwater. The deeper basin water contains much higher TDS, and thus older, groundwater (Figure 3–19).

USGS has shown a region of groundwater from the Fruitland Formation that is high in TDS and feeds the alluvial fill aquifer as the San Juan River crosses the Fruitland subcrop in New Mexico. The work of others, including the 3M Model, GRI (1990), McCord et al. (1992), Scott (2000), and Berry (1959), indicate that the groundwater from the deep basin of the Fruitland Formation discharges at the San Juan River; thus, the occurrence of water high in TDS at the Fruitland subcrop is consistent with the overall interpretations by these workers.

3.5.3.2 Stable Isotopes — Oxygen and Hydrogen and Paleoclimates: Evidence of Groundwater Age

The stable isotopes of oxygen and hydrogen can be used to identify the origin of groundwater. Their position relative to the Global Meteoric Water Line (GMWL) can identify the source of the water molecules when the ratios of the oxygen and hydrogen stable isotopes, ^{18}O and ^{16}O and H and 2H (deuterium) are plotted. If the data plot near the GMWL, then it can be concluded that the water fell as precipitation and eventually infiltrated into the aquifer system, where it has been ever since. If the data plot well off the GMWL, it can be concluded that there have been significant evaporative effects before infiltration, or that there have been some high-temperature water-rock interactions, or mixing with connate waters that were deposited with the sediments.

More than 100 samples of produced water were analyzed for their stable isotope ratios. The results for all but five samples plot close to the GMWL (Figure 3–20). This finding indicates that the majority of groundwater from the Fruitland Formation is meteoric, with no mixing of brackish connate water, seawater, and no significant diagenetic interactions. Although the stable isotopes do not provide an

age date of the groundwater, the distribution of the stable isotope ratios in the groundwater from the Fruitland Formation can be tied to the past climate of the Project Area. First, there is a region of low (isotopically light) water that lies up to 5 miles off the Indian Creek recharge area, and another area of isotopically light water that appears to be migrating subparallel with the Pine River drainage (Figure 3–21). The light water could have fallen at some point in the geologic past when the climate was significantly cooler than today. During the most recent glaciation, the glaciers receded from the Project Area around 10,000 years before present (ybp). Global stable isotope transfer functions from Domenico and Schwarz (1990) indicate that mean average temperature was 1.5°C when the isotopically lightest water fell as precipitation. Today's mean average temperature in the Durango area is 7.7°C.

The 3M MODFLOW simulations predict a 10,000 year travel time from the recharge areas on the outcrop to the same areas of the Fruitland Formation where the isotopically light waters are found. This agreement indicates that the MODFLOW simulations are accurate when used to depict velocities of groundwater flow through the Fruitland coal beds.

The isotopically heavy groundwater within the deep basin is also meteoric (Figure 3–20 and Figure 3–21). However, the ages of this water could range from 100,000 years to more than 1,000,000 years. At present, the only reliable method of age dating the groundwater in the deep basin is to use inferred age dates from the 3M MODFLOW studies. Many uncertainties are associated with radioisotope age dates and are unreliable at this time, as discussed below.

3.5.3.3 Helium Age Dates

Zhou et al. (2002) published groundwater age dates from samples of noble gas collected from the gas streams of producing CBM wells in New Mexico. The estimated groundwater age dates, based on He-4, range from 3 million years before present (Ma) to 14 Ma, significantly lower than the I–129 age dates from the same area. Zhou et al. (2003) revised the age dates, accounting for the crustal flux of He-4. Revised age dates range between 1,900 to 100,000 years in the overpressured region of Zhou's study area and between 7,200 and 39,000 years in the underpressured region.

The He-4 age dates for most of the samples were less than 10,000 years. However, these authors caution that the "dominant uncertainty used to derive the groundwater He-4 dates is in the assumption of an average crustal external He-4 flux into the aquifer system. Although the absolute dates are currently subject to significant uncertainty, the relative He-4 dates obtained will be reasonable."

The helium age dates display a systematic aging of the groundwater as it moves from recharge areas to the deeper basin in the underpressured portion of the basin. In the "fairway" or the high production, overpressured areas to the north, the groundwater age dates are almost uniform.

Others (Sorek and Sanford 2002) have postulated a He-4 age date of 29 Ma in produced water from the Fruitland Formation. Given the orders of magnitude differences between various workers for He-4 age dates from produced water

from the Fruitland Formation, none can be reliably used to calculate the ages of groundwater from the Fruitland Formation.

3.5.3.4 Tritium Age Dates

In 2000, BLM collected and analyzed six samples of produced water for tritium activity. Tritium is a radioactive isotope of hydrogen that is produced when atomic weapons explode. Large quantities of tritium were injected into the atmosphere in the 1950s and 1960s when the U.S., Soviet Union, and France were conducting extensive aboveground testing of thermonuculear weapons. With a short half-life of 12.3 years, tritium can provide a signal only for groundwater that is on the order of 30 to 60 years old (rain and snow that fell from the 1950s through the 1980s). Younger water does not contain sufficient tritium for age dating because atmospheric testing of thermonuclear weapons ceased in the 1960s.

The Southern Ute well 12U–2, located in the Indian Creek area, contained 134 (+/-5) Tritium Units (TU), indicating that the water produced by this well was approximately 45 years old and has been isolated from the atmosphere since that time. The Southern Ute well 12U–2 is approximately 0.75 mile basinward of the recharge area, and groundwater flow velocity can be accurately estimated from this relationship. A flow velocity of 88 feet/year was calculated (0.073 meters/ day) from these values.

Tritium results for the other wells and the sample from the Pine River all show no TUs (Table 3-10). Therefore, the water is either too old for tritium age dating, or is too young and does not contain a tritium signature.

Table 3-10 Results for Analysis of Tritium

Well Name	Location	Tritium Units[1]
Federal/SPC 2–14	Sect 14 35N 8W	<1
BP Richardson Fed F 1	Sect 2 34N 8W	<1
BP Dulin D 1	Sect 26 35N 7W	<1
BP Evelyn Payne A 1	Sect 32 35N 6W	<1
So Ute 21–1	Sect 21U 33N 11W	<1
Indian Creek 12U–2	Sect 12U 34N 10W	134 +/- 5
Pine River[2]	Near Dulin D 1	<1

Notes:
1. All samples collected during March 2000.
2. Surface water sample.

3.5.3.5 I–129 Age Dates

I–129 is a radioisotope that can be used for age dating rocks and, in some cases, pore waters. The majority of peer-reviewed published literature recognizes that I–129 does not provide a valid age date for groundwater because groundwater leaches iodine as it flows through the formations (Fabryka-Martin et al. 1991, Fabryka-Martin 2000; Fehn et al. 1991).

Further confounding the use of I–129 age dates is the addition of fissiogenic I–129 from the decay of U–238. Where uranium may be concentrated in the subsurface, a very high level of I–129 may be present, leading to artificially younger dates. Conversely, the groundwater may be leaching iodine from the rock where it does not encounter these uranium deposits along the flow paths.

In one study, I–129 age dates in water were used to calculate the age of the formation groundwater was flowing through (60 to 80 Ma); however, the residence times of the groundwater were determined to be 80,000 years. This study, and others, illustrates the shortcomings in concluding groundwater ages from I–129 age dates.

Furthermore, the use of I–129 age dates conflicts with the He-4 ages of Zhou et al. (2002) and the temperature profiles of McCord et al. (1992), as well as the thousands of pressure, permeability, and production data points analyzed in the 3M Study.

A contour plot of the I–129 age dates (Figure 3–22) illustrates the contradiction between the I–129 age dates when compared with the TDS contour plot (Figure 3–19), stable isotope contour plots (Figure 3–21), groundwater flow paths (Figure 3–23 and Figure 3–24), and other data that have been constrained by or complement the physical data from the Fruitland Formation (pressure, temperature, production data, and well logs).

The conceptual model proposed by Riese et al. (2005), submitted by BP in comments, describes a stagnant system in the Fruitland Formation, with connate waters trapped in the coal beds since they were deposited in the Late Cretaceous. The pressure regime in the Fruitland Formation was explained by the introduction of recharge water during the Eocene, 30 to 35 Ma, during the San Juan uplift. Shortly after this water was introduced, all flow within the Fruitland Formation ceased.

The conceptual model developed from 100 data points of poorly understood geochemical data cannot be supported when 100 data points do not match the work of others who have analyzed multiple lines of physical evidence of fluid flow and workers who have used hundreds of thousands of data points in the analysis. Furthermore, the He-4 ages dates from Zhou et al. (2002 and 2003) show groundwater ages that are orders of magnitude lower than the I–129 age dates. BLM continues to work with multiple lines of physical and chemical data, along with direct observations on the outcrop, to describe the effects of CBM development in the SJB. Furthermore, several compartmentalization scenarios were tested with the 3M flow model. These scenarios showed conclusively that the predevelopment pressure field in the Fruitland Formation cannot be maintained for the millions of years required by the conceptual model put forward by Riese et al. (2005).

3.5.4 Groundwater — Surface Water Interactions

According to the assumptions incorporated into the 3M model (Questa 2000) and the Cox et al. (2001) study, general flow patterns in the Fruitland Formation are from the recharge areas along the high-elevation ridges of the outcrop to the dis-

charge areas at the river cuts. Figure 3–23 and Figure 3–24 illustrate the general flow paths of groundwater in the Fruitland Formation and Pictured Cliffs Sandstone before CBM development began.

Hydrologic budgets for the Fruitland Formation were developed during the 3M Study. Coals in the Fruitland Formation were estimated to transport approximately 280 acre-feet/year from recharge areas to discharge areas. This estimate applies to the entire San Juan Basin. In the Project Area; approximately 200 acre-feet/year are accounted for by recharge and river discharge. The remaining 80 acre-feet/year flows into the deep basin and discharges at the Rio Puerco and San Juan River in New Mexico.

More detailed modeling, supported by the Ground Water Protection Research Foundation (2001), demonstrated that CBM development will ultimately intercept much of the groundwater that discharges to the Animas, Pine, Florida, and Piedra Rivers, all located in the Project Area.

Current effects of CBM development show that 65 acre-feet/year are being intercepted and are no longer discharging to the area's rivers. The incremental effects of additional infill wells were found to be minimal when compared to the depletions that would occur from current CBM wells. In other words, depletions in surface water flow at the Animas and Pine Rivers were not sensitive to well spacing of 320 acres or 160 acres. There was a slight 6 acre-feet/year incremental depletion effect at the Florida River as a result if infill wells analyzed in this EIS. The Piedra River, though not impacted by current CBM development, displays hydrogeologic characteristics similar to the other rivers and would be expected to also be impacted by future CBM development.

Maximum depletions are projected approximately 132 to 200 acre-feet/year from all four rivers and varies by alternative (Table 3-32, Section 3.6). The large majority of this volume of depletion is predicted to occur by 2015 and to continue for several centuries or until the Fruitland aquifer is recharged (Figure 3–28). After the aquifer is recharged, the surface water and groundwater interactions will return to the pre-CBM development conditions.

3.5.5 Groundwater Use

Groundwater resources in the Fruitland Formation and Pictured Cliffs Sandstone are exploited at the outcrop, or near the rim of the basin where burial depths are less than 500 feet. In two cases, deeper wells tap into the Pictured Cliffs Formation (Wildarado Ranch and Artesian Valley). These wells are deeper than 1,000 feet. The Wildarado Ranch well was originally drilled as a gas exploratory well and was eventually converted to a water well and conveyed to the landowners for their use.

As many as 40 shallow domestic wells draw groundwater from the Fruitland Formation or Pictured Cliffs Sandstone near the outcrop areas (Figure 3–15). These water wells are less than 300 feet deep, and many draw water from coal bed aquifers, which are higher in permeability and provide better yield when compared with the saturated mudstones and sandstones. One shallow groundwater well is a flowing artesian well (Sec 19, T34N, R6W). The well is located immediately

south of the outcrop of the Fruitland Formation ridge, in a small pasture underlain by weathered Kirtland Shale. This well is used for stock water, and overflow from the stock tank is used to irrigate a small portion of a nearby pasture. Other shallow wells on the outcrop appear to be situated in the immediate recharge areas; therefore, these are not flowing artesian wells.

3.5.6 Public Scoping Issues

Issue 1: The effects of additional CBM development on groundwater resources.

The following are specific facets of this issue:

- *Potential for CBM dewatering to deplete groundwater in shallow aquifers.*
- *Altering the basin hydrology by injection of produced water into deeper formations.*
- *Dewatering in the Fruitland Formation may adversely affect water wells by lowering the water table.*
- *Dewatering the Fruitland Formation may lead to mixing of groundwater.*
- *Injection in deeper formations may lead to mixing of groundwater.*
- *Mixing of groundwater may adversely affect groundwater supplies by increasing the total dissolved solids or other dissolved constituents.*
- *Water rights may be affected by alteration of the basin hydrology.*
- *CBM dewatering and injection may affect surface water where there is groundwater and surface water interaction.*

3.5.7 Current Conditions — Groundwater Effects from Existing CBM Development

CBM development effects on groundwater resources can be divided into effects on shallow groundwater that is exploitable for water supplies (domestic or livestock), direct effects of withdrawals on the Fruitland Formation and Pictured Cliffs Formation, and direct effects of injection of produced water into deeper aquifers such as the Dakota Sandstone and the Entrada Formation.

Because of the land and mineral ownership patterns in the Project Area, no sharp quantitative distinctions can be made between jurisdictions in terms of their contribution to environmental consequences analyzed in this Groundwater Section. Generally, in the western project area, wells contributing to environmental consequences are represented mostly by private/state wells and less so by federal wells. In the eastern Project Area, which is less developed, the number of wells that would be developed is weighted more towards federal wells and less towards private and state wells. Thus, for the eastern Project Area, on a proportionate basis, federal wells would contribute more heavily to the environmental consequences noted.

3.5.7.1 Effects on Shallow Groundwater

Currently, as many as 40 domestic water supply wells (Figure 3–15) use the Fruitland Formation or the Pictured Cliffs Sandstone as the source of water. CBM development has directly affected one domestic well, located in the Texas Creek drainage, by lowering the water table to the point the well required replacement with a deeper well. The original water well drilled at Texas Creek was installed to a depth of 90 feet. Water levels were normally at about 20 to 30 feet, with a sustained yield of 20 gpm. No problems with water quantity were encountered for the 10 years that preceded the start of CBM development. Within 6 years, the water levels had diminished to 65 feet below ground surface, with no changes in water demand. Yield had dropped to less than 1 gpm. The deeper replacement well was 190 feet deep and continues to provide sufficient water quantities to the owners. Water level measurements collected from this well indicate seasonal fluctuations, but no long-term decline has been observed. Direct effects at other domestic wells have not been documented or reported.

Some landowners have reported that CBM development has affected the water supply during hydrofracturing or cavitation. It is likely that the local vibrations induced by these activities may loosen or suspend some of the fine-grained materials around the shallow domestic well bores, causing discoloration of the water from these wells. These conditions are temporary and landowners report that the discoloration clears up several days after the work at the CBM well is completed. Another factor that may contribute to discoloration of the groundwater produced from shallow wells is the poor condition of many shallow domestic wells. Often, landowners are not aware of maintenance that is required on domestic wells, such as periodic well development and disinfection. When well maintenance is neglected, even slight vibrations may agitate fine-grained material into suspension, causing discoloration of the water for several days.

3.5.7.2 Direct Effects of Groundwater Withdrawals from CBM Wells

Cumulatively, approximately 1,050,000 gallons (3.22 acre-feet or 25,000 barrels — see conversions below and in Glossary) of water per day are produced from the existing CBM well field in the Project Area. This water is mostly produced from the coal beds, with minor amounts produced from the Pictured Cliffs Sandstone, such as at the Dulin D-1 well. Volume unit conversions: "Acre-foot" one acre/foot is the volume of water that will cover one acre to a depth of one-foot and equals 325,851 gallons; "barrel" is a commonly used unit of volume used in the oil industry. It is not commonly used when describing groundwater or surface-water volumes. One barrel equals 42 gallons.

The water budget for a typical CBM well completed in the Fruitland Formation shows that 41,580,000 gallons (127.6 acre-feet) of water are contained in the coal beds within a 160-acre spacing unit. This water is the volume found in the cleat porosity (primary porosity) of the coal beds. A typical well in the Fruitland Formation has produced approximately 10,500,000 gallons (32.7 acre-feet) of water since it began producing. Therefore, only about 26 percent of the water contained in the Fruitland Formation coal beds has been produced by the typical well completed in the Fruitland Formation to date. Furthermore, no significant volume of

water has been leaked into the coal beds from overlying strata, nor have the CBM wells in the Fruitland Formation produced significant quantities of water from the Pictured Cliffs Sandstone on a regional scale. Locally, several wells appear to be pumping water from the Pictured Cliffs Sandstone.

As discussed above, the Kirtland Shale effectively seals off the shallow aquifers from the Fruitland Formation, thereby isolating the hydraulic effects of CBM development from the shallow aquifers.

3.5.7.3 Direct Effects of Produced Water Injection into Deeper Aquifers

Approximately 505,069 gallons (1.55 acre-feet) per day of produced water are injected into the Dakota Sandstone and 546,000 gallons (1.68 acre-feet) per day are injected into the Entrada Formation.

As pressure builds up in the Dakota and Entrada Formations from injection of produced water, the pressure in these formations will gradually increase within a specified radius from the injection well. Increases in pressure at any point within these formations are a function of the injection well's operating pressure, which depends on the injection rate and the thickness and permeability of the formation. EPA and Colorado regulations require all injection wells be operated so that the injection pressures do not induce fracturing in the formation, thereby confining the injected water in the target zone. The Underground Injection Control program which regulates water injection, delegated from EPA to the State of Colorado, requires that injection not "manifest themselves in shallow aquifers or useable groundwater supplies."

Current effects involve the gradual increases in formation pressures. Previously, one effect on groundwater resources was the observed increase in flow and temperature at the Hickerson Hot Spring that occurred when injection began at the Simon Land and Cattle injection well operated by BP. Initially, produced water was injected into the Wanakah Formation. When the well was recompleted to inject produced water in a different zone (the Dakota Formation), there was a corresponding decrease in flow rates and temperatures at the Hickerson Hot Spring. These decreases indicated an interconnection between the injection well and the hot spring.

This correlation between flow rates and temperatures at the hot spring and the operating history of the injection well indicates a regional open fracture system or open fault zone that interconnects the deeper parts of the San Juan Basin and the outcrop areas of the lower Cretaceous strata. This case is isolated, however. Still, other instances may come to light after new injection wells are installed and begin operating.

Mixing between produced water and the native formation waters will not affect exploitable or useable groundwater resources in the San Juan Basin because no groundwater supply wells tap into the formations where water is disposed.

3.5.8 Affected Resources and Environmental Consequences — Groundwater

CBM development in the SJB affects useable groundwater resources along the outcrop of the Fruitland Formation. Other groundwater resources are affected by the withdrawal of water from Fruitland coal beds and the injection of this water into deeper formations.

Increased development will increase the total volume of water extracted from the coal beds and injected into the deeper formations.

Increased CBM development will also increase drawdown of shallow groundwater resources along the outcrop of the Fruitland Formation, possibly to the point where the domestic wells are no longer viable. As many as 40 domestic water-well owners may be affected by lower water tables in the outcrop area. Most of these domestic wells are in the western Project Area and would be affected by CBM well development of private, state, and federal jurisdictions.

The two deeper wells known to draw water from the Pictured Cliffs Sandstone are not likely to be affected to any significant degree by increased CBM development activity. Rather, lowering the water levels in these wells will continue as a result of the existing level of CBM development on all jurisdictions.

Impacts discussed for each alternative below are restricted to the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone. Impacts to groundwater resources within the interior of the basin are considered highly unlikely to occur. Shallow aquifers in the interior San Juan Basin are hydraulically isolated from the Fruitland Formation and will not be depleted by CBM development.

3.5.8.1 Alternative 1 — Proposed Action

3.5.8.1.1 Potential for CBM Dewatering to Deplete Groundwater in Shallow Aquifers

As noted above, the Fruitland Formation is a confined hydrostratigraphic unit throughout most of the Project Area. Dewatering the coal beds will not affect the shallow aquifers that supply nearly all the domestic wells, municipal wells, and livestock wells in the Project Area.

Increased development of CBM in the western Project Area on all jurisdictions will continue to draw down the water levels in wells located along the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone. As noted above, 40 private wells are located on the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone. Any number of these private well owners could be affected by ongoing CBM production.

The two deeper water wells in the Pictured Cliffs Sandstone (Wildarado Ranch and Artesian Valley) have been affected by current CBM development. Alternative 1 may accelerate the drawdowns observed in these two wells by accelerating pressure depletions in the Fruitland Formation and the Pictured Cliffs Sandstone. The overall effect on these two private wells would be to limit the useable quantities of water available to the well owners.

Groundwater effects in the eastern Project Area are also predicted to include drawdown of the water table along the outcrop, with possible effects on domestic wells. Groundwater discharging to the Piedra River from the Fruitland Formation may be intercepted and, if so, there will be an associated reduction in base flows to the Piedra River. For further discussion, see Section 3.6, Surface Water.

The limited data available in the eastern portion of the Project Area suggests that the ground water system may respond to CBM development differently than has been observed in the western Project Area. The coals in the eastern Project Area appear to be dryer than the western Project Area coals; thereby little water is produced by CBM wells. With less water produced by CBM wells, there may less potential for groundwater draw down as a result, or the effects to the shallow aquifer of CBM production may not be realized as rapidly as observed in the western Project Area. The monitoring program outlined in Section 3.5.10 and as required by the COGCC, is designed to detect changes in hydrologic conditions, including impacts to water wells, at the Fruitland Formation outcrop as a result of CBM development. Depending upon the results of the monitoring, conditions of approval of future CBM development may be either tightened or relaxed.

3.5.8.1.2 Altering the Basin Hydrology by Injection of Produced Water into Deeper Formations

Although the deep hydrology of the basin will be affected by injection of produced water, these effects are not expected to manifest themselves in shallow aquifers or useable groundwater supplies. In other words, the injected produced water will increase pressure in the deep formations and alter the chemistry of groundwater in the deep formations. However, these effects will not be evident so long as injection wells are constructed and operated according to current regulations and best engineering practices. The underground injection control (UIC) program that regulates water injection, delegated from EPA to the State of Colorado requires that injection not "manifest themselves in shallow aquifers or useable groundwater supplies".

3.5.8.1.3 Mixing of Groundwater through Dewatering and Injection

Mixing groundwater between aquifers will not occur from dewatering the Fruitland Formation.

Alternative 1 would increase the amount of groundwater mixing in deeper formations by increasing the overall volume of injected water and the number of disposal wells that inject produced water.

3.5.8.1.4 Surface Water

Impacts to surface water resources are discussed in Section 3.6, Surface Water.

3.5.8.1.5 Wildlife

Wildlife may be affected by withdrawals of groundwater from the Fruitland Formation only insofar as they relate to the interactions between groundwater and surface water. Springs along the outcrop may dry up, and there will be minor depletions in base flows of surface water in rivers and creeks that are fed by

groundwater discharge from the Fruitland Formation. These effects are discussed in Section 3.6, Surface Water.

3.5.8.2 Alternative 2

3.5.8.2.1 Potential for CBM Dewatering to Deplete Groundwater in Shallow Aquifers

Alternative 2 would draw down domestic wells along the outcrop of the Fruitland Formation and Pictured Cliffs Sandstone much the same way as Alternative 1. Drawdowns could be accelerated due to the increased number of wells drilled within close proximity of the Fruitland outcrop (Chapter 2, Figure 2–3). Drawdowns may not be observed in all domestic wells because of their proximity to recharge areas. However, it is expected that some number of the 40 known private domestic wells will be affected by drawdowns associated with CBM development. Most of the domestic wells are in the western Project Area where wells on all mineral jurisdictions contribute to Fruitland aquifer impacts.

Shallow groundwater impacts are predicted to be realized in the eastern Project Area as a result of Alternative 2 due to the large number of wells on National Forest, and private mineral estate that would draw water from the Fruitland aquifer. Because there would be substantially more wells drilled in the eastern Project Area compared to Alternative 1, there would be greater potential for groundwater impacts, and impacts possibly occurring sooner than would be realized with less development represented by the other alternatives.

As many as 40 wells located on the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone could be affected by ongoing CBM production. Alternative 2 may accelerate these potential effects.

3.5.8.2.2 Altering the Basin Hydrology by Injection of Produced Water into Deeper Formations

Impacts would be similar to Alternative 1. The primary difference is that increases in pressure in deeper formations would extend over a broader area because of the increased number of injection wells.

3.5.8.2.3 Mixing of Groundwater through Dewatering and Injection

Impacts would be similar to Alternative 1. Alternative 2 would increase the amount of groundwater mixing in deeper formations by augmenting the overall volume of injected water and the number of disposal wells injecting produced water.

3.5.8.2.4 Surface Water

Impacts to surface water resources are discussed in Section 3.6, Surface Water.

3.5.8.2.5 Wildlife

Overall, impacts to wildlife are likely to be greater when compared with Alternative 1 because operation of a dense network of CBM wells in close proximity to the recharge areas along the outcrop is likely to have a more direct effect on groundwater seeps and springs. Alternative 2 is likely to dry up more sources of water more rapidly than would Alternative 1.

3.5.8.3 Alternative 5 — No Action

Alternative 5 would result in the same groundwater impacts as Alternative 1 in the western Project Area due to existing development and projected development on private and state mineral estate. The outcrop area affected would be a mixture of lands under federal, State, and private jurisdictions in the western Project Area.

Most of the known private domestic wells located on the outcrop of the Fruitland Formation are in western Project Area in La Plata County in an area already subject to groundwater depletions. As noted above, 40 private wells are located on the outcrops of the Fruitland Formation and Pictured Cliffs Sandstone. Any number of these private well owners could be affected by ongoing CBM production.

Because there would be no development of federal mineral estate, Alternative 5 may result in lower impacts to the water table at the outcrop of the Fruitland Formation in the eastern Project Area. The only wells developed in the eastern Project Area would be a cluster of approximately 14 wells on private mineral estate/federal surface and two state wells. These wells may have minor impact on Fruitland groundwater regimes at the outcrop. COGCC monitoring requirements for private well development in the eastside Project Area require annual monitoring of all private water wells within a nine-mile area north, immediately adjacent to, and south of the locations where the private wells would be drilled (Section 3.5.10). One COGCC required mitigation hat applies to private wells drilled within the area, would be to limit the amount of water produced from private CBM wells. This limitation of water production may reduce the impacts to groundwater at the Fruitland Formation outcrop. This same limitation could be used as a condition of approval of federal wells as warranted.

Alternative 5 would also inject lower amounts of produced water into deeper formations, reducing the amount of mixing and the degree of pressure buildup in these deeper formations.

3.5.8.4 Alternative 6

3.5.8.4.1 Potential for CBM Dewatering to Deplete Groundwater in Shallow Aquifers

Alternative 6 impacts in the western Project Area would be essentially the same to those described in Alternative 1 because of the same level of CBM development would occur on all jurisdictions. As many as 40 domestic water-well owners may be affected by lower water tables in the outcrop area.

Alternative 6 impacts in the eastern Project Area would be as described for Alternative 5 — the No Action Alternative. As with Alternative 5, CBM development would be limited to 14 wells developed on private mineral estate/federal surface and two wells on State lands. There would be no federal development within 1½ miles of the Fruitland outcrop. The 16 CBM wells may have minor impact on Fruitland groundwater regimes at the outcrop. As described above, COGCC monitoring provisions placed on private wells in the far eastside Project Area require comprehensive water well monitoring. COGCC required mitigation would be to limit the amount of water produced from CBM wells if necessary.

This limitation would reduce the impacts to groundwater at the Fruitland Formation outcrop.

3.5.8.4.2 Altering the Basin Hydrology by Injection of Produced Water into Deeper Formations

Since there are fewer production wells on National Forest in this alternative when compared to Alternative 1, the volume of produced water would presumably be less. Therefore, the pressure changes in the deep formations would be less and would have a smaller area of influence.

3.5.8.4.3 Mixing of Groundwater through Dewatering and Injection

Impacts would be similar to those described in Alternative 1. This alternative would decrease the amount of groundwater mixing in deeper formations by lessening the overall volume of injected water.

3.5.8.4.4 Surface Water

Impacts to surface water resources are discussed in Section 3.6, Surface Water.

3.5.8.4.5 Wildlife

Overall, impacts to wildlife are likely to be essentially the same as described Alternative 1 in the western Project Area and potentially les than Alternative 1 in the eastern Project Area due to the limitation of CBM development within proximity of the Fruitland outcrop to private mineral estate only.

3.5.8.5 Alternative 7

3.5.8.5.1 Potential for CBM Dewatering to Deplete Groundwater in Shallow Aquifers

Alternative 7 impacts would be essentially the same those described for Alternative 1 in the eastern and western Project Area.

3.5.8.5.2 Altering the Basin Hydrology by Injection of Produced Water into Deeper Formations

Impacts would be similar to those described in Alternative 1. Since there are fewer production wells in Alternative 7 as compared to Alternative 1, the volume of produced water would presumably be less.

3.5.8.5.3 Mixing of Groundwater through Dewatering and Injection

Impacts would be similar to Alternative 1. This alternative would decrease the amount of groundwater mixing in deeper formations by lessening the overall volume of injected water.

3.5.8.5.4 Surface Water

Impacts to surface water resources are discussed in Section 3.6, Surface Water.

3.5.8.5.5 Wildlife

Overall, impacts to wildlife are likely to be essentially the same as described Alternative 1.

3.5.9 Cumulative Effects

Groundwater extraction may ultimately affect wildlife and possibly riparian areas through the drying of seeps and springs. It will deplete surface water volumes in the rivers to varying degrees. This impact has the potential to occur along the Fruitland Formation outcrop both n side and outside the Project Area. The area of potential impact stretches from the Colorado – New Mexico border east to the Piedra River. This area of greatest concern for this impact is the Fruitland outcrop area between Valencia Canyon Gap on the west to the Piedra River in the eastern Project Area (Figure 3–8).

Deep injection effects, such as mixing different water types or pressuring the receiving formation, would not be observed in the human environment and would have no effects on other resources.

Groundwater drawdown at the outcrop may also affect some of the domestic wells that tap the Fruitland Formation for their supply.

Alternatives 1, 2, and 7 would all have similar levels of cumulative effects on the groundwater resources. Alternatives 6 and 5 would have somewhat lesser cumulative effects than the other three alternatives.

3.5.10 Mitigation and Monitoring

Unless otherwise stated, the following measures would be funded by the Companies. See also the mitigation and monitoring section in Chapter 3.3. Mitigation measures for groundwater effects include:

- Operators remediate or otherwise replace affected domestic wells on the Fruitland outcrop with an alternative permanent water source (i.e., new well or a cistern with water delivery service provided by the operator indefinitely).
- Treating and discharging CBM produced water into area streams to replace the volumes depleted through CBM production. This would require further analysis and permitting before implementation.

The following monitoring program addresses groundwater effects of the alternatives. The scale of the monitoring program would be tailored to the selected alternative and conducted in such a way that it can be changed over time and adapted to field monitoring needs. Depending upon the results of the monitoring, conditions of approval on future drilling and development may be modified.

Based on monitoring experience in La Plata County, the monitoring requirements described below provide an effective and comprehensive approach to monitoring current conditions at the outcrop, identifying changes should they occur in vegetation, ground water, and surface water, and determine what the cause of changes are.

- Install groundwater-monitoring wells and/or shallow piezometers along the outcrop of the Fruitland Formation, to evaluate whether the effects of CBM dewatering extend to the outcrop in all areas, or whether portions of the outcrop may be hydraulically isolated from the down dip produc-

ing areas. Initially, the primary focus of groundwater-level monitoring would be to monitor shallow, near-outcrop water levels, but there may also be a need for deeper wells, located further from the outcrop to monitor down-hole pressure and groundwater levels to provide comprehensive information about Fruitland Formation hydrogeology.

- Fund and complete the ongoing USGS study of groundwater/surface-water interaction of the Fruitland Formation and the Piedra River and, potentially, extend the study to the Florida and Pine Rivers.
- Inventory springs, wells, and groundwater seeps (wetlands) along the outcrop of the Pictured Cliffs and Fruitland and Kirtland Formations.
- Continue monitoring water levels at the Walker well (Texas Creek), the Meloche well (Pine River area – Kirtland Formation), and the Bureau of Reclamation piezometers in the Ridges Basin area.
- Monitor water levels at springs and wells, measure flows at springs (download data loggers, maintain database).
- Collect time-series water chemistry and temperature data from producing CBM wells.
- Install and maintain a weather-monitoring station to measure precipitation, temperature, barometric pressure, and wind speed and direction.

The following are COGCC-required monitoring that applies to private mineral estate/federal surface wells proximal to the Fruitland Formation outcrop in the eastern Project Area. These same requirements would be considered as a condition of approval for APDs issued for federal wells.

The requirements purpose are to monitor the current conditions at the outcrop, identify changes should they occur in vegetation, ground water, and surface water, determine what the cause of changes are, limit the amount of water co-produced with the gas from their CBM wells, identify and monitor plugged or dry and abandoned wells in this area to ensure that they are not acting as conduits for gas migration, and to provide an EPP to Archuleta County. The requirements apply to a sixteen mile area and involve multiple operators. The requirements tie to monitoring efforts underway in La Plata County.

The following are the conditions of approval that would be applied to the permits once they are complete and approved:

- Fruitland Outcrop Reconnaissance — During 2005 and then on an every 3 year basis (e.g. 2008, 2011, etc), a low altitude, high-resolution aerial photography will be used to map the vegetation along the Fruitland Formation in those sections of land in T34N R5W, SUL and Sections 9, 13, 14, 15, and 16 in T34N R5W, NUL in which the Fruitland Formation outcrops. This work will coincide with and be tied into similar work conducted in La Plata County under COGCC Orders 112–156 and 112–157. Once the aerial imagery is reviewed, "suspect" areas requiring further field investigation will be identified. Using a GPS and the IR imagery the suspect areas will be located and surveyed for the presence or absence of methane, carbon monoxide, and hydrogen sulfide. If methane seeps or seeps of other gases from the outcrop of the Fruitland Formation are identified, then the operator shall develop a plan for mapping the

seeps in detail and monitoring the seeps to identify any changes in extent of impacted area, and volume, concentration, composition, and stable isotope ratios. In addition, the operator shall attempt to identify the cause of the changes.

- Fruitland Outcrop Spring Survey — during summer 2005 an initial regional reconnaissance survey to identify all springs that emanate from or that appear to emanate from the outcrop of the Fruitland Formation in T34N R5W SUL and Sections 9, 13, 14, 15, and 16 in T34N R5W NUL shall be surveyed, including accurately locating each spring using GPS or other land survey technology. Thereafter these springs shall be visited on an annual basis at approximately the same time of the year as the 2005 survey. At a minimum, methane concentration, water chemistry, and flow rate shall be tested and measured.
- Ground Water Monitoring Program — On an annual basis the operator will monitor private water wells in those sections of land in T34N R5W SUL and Sections 9, 13, 14, 15, and 16 in T34N R5W, NUL in which the Fruitland Formation outcrops following the parameters established in COGCC Orders 112–156 and 112–157. Prior to start up of any drilling activities, the operator shall provide the COGCC and BLM with a list of all tested water wells, the analytical results, and the locations surveyed using GPS or other accurate method. Copies of all test results shall be provided to the COGCC, BLM and the landowner within 3 months of collecting the samples used for the test.
- Produced Water Limitations — The operator shall limit water production to less than 100 barrels of water per day per well. Once the wells are online and producing and drilling and completion fluids have been removed from the wells, the operator shall collect one water sample from each well and analyze these samples for major anions and cations, TDS, pH, conductivity, and other parameters as appropriate. These data shall be provided to the COGCC and BLM within 3 months of sample collection.
- Post Completion Pressure Build-Up Test — after completion and prior to sales a bottom hole pressure measurement must be made using a bottom hole gauge after a 48-hour shut-in period. The operator shall provide these data to the COGCC and BLM within one month of conducting each test.
- Soil Gas Survey — The Big Horn-Schomburg #1 (05–007–05100) well is located in SESE Section 14 T34N R5W. This well was drill and abandoned in 1961 and from the records available to the COGCC it appears that the top of the Fruitland Formation is close to or comes to the ground surface at this location. Prior to beginning production of any of the proposed wells, the operator shall conduct a soil gas survey around this well, shall establish at least one permanent soil monitoring probe (vapor tube) at this location, and shall survey the area on an annual basis. See #7 below for additional requirements regarding this DA well.
- Plugged and Abandoned Wells — The operator shall attempt to identify all P&A wells located within one mile of a proposed well location. Any P&A well within one mile of a proposed well that is identified shall be assessed for risk taking into account cementing practices reported in the

P&A. The operator shall notify the COGCC and BLM of the risk assessment of plugging procedures. The agencies shall review the risk assessment and take appropriate action to pursue further investigation and remediation if warranted.

- Emergency Preparedness Plan — The operator shall submit an EPP to Archuleta County. The EPP shall include as-built facilities maps showing the location of wells, pipelines, and other facilities, except control valve locations that may be held confidential. The EPP shall include an emergency personnel contact list, that must be updated whenever the contact information changes.

3.5.11 Conformance to Existing Plans and Policies

For all alternatives, groundwater depletions are predicted to impact surface waters. This is a result of CBM wells intercepting and producing groundwater that otherwise would have contributed to the recharge of surface waters in the Project Area.

Surface water rights are administered by the State Engineer's Office in Colorado. To comply with the regulations and policies of the State Engineer's Office, the Companies may be required to obtain surface water rights or enter into water augmentation plans to compensate for ground water depletions and subsequent surface water impacts. See Surface Water and Wildlife Sections also.

3.5.12 Unavoidable Adverse Effects

The effects of CBM development on the Fruitland Formation and Fruitland outcrop, as discussed in previous sections, are considered unavoidable adverse effects, particularly in the La Plata County portion of the Project Area. These include:

1. Drying of water seeps and springs
2. Associated effects on wildlife and vegetation types
3. Dewatering domestic wells along the outcrop
4. Depletion of surface water flows in area rivers

Although these adverse effects may occur in Archuleta County, due to lack of development and associated data the extent of such impacts cannot be projected at this time. For this reason, monitoring emphasis is placed on the collection of relevant baseline data and the conduct of continuous monitoring of the groundwater, surface-water regimes in order to detect and manage for change.

3.5.13 Irreversible and Irretrievable Effects

Irretrievable effects on groundwater resources include:

- Depletions of groundwater in the Fruitland aquifer, including near the outcrop
- Depletions of surface water flows in the Animas, Florida, Pine, and Piedra Rivers.

According to projections by Cox et al. (2001), groundwater discharge from the Fruitland Formation to the Animas, Pine, and Piedra rivers will be 100 percent eliminated by the year 2050 (the approximate maximum projected life of the gas field). Similarly, groundwater discharge to the Florida River is projected to be reduced by about one third over the same time period. Therefore, the total volume of lost surface-water flows in these four rivers is projected to range from 155 to 200 acre-feet per year (Cox et al. 2001). Given this average annual rate of loss, the long term (50+ years), cumulative volume of water lost to the surface water system is projected to be between 7,800 and 10,000 acre-feet. CBM development on all jurisdictions would contribute to these reductions in groundwater discharge.

After groundwater pumping for CBM development ceases, the Fruitland aquifer system will begin to recharge, and groundwater discharge to surface water would eventually be naturally restored. This recovery process could take a century or more to return the groundwater/surface-water system to something similar to the pre-development water balance. Given this long recovery time, the effect is considered irretrievable for the purposes of this analysis.

Groundwater drawdown at the outcrop may affect up to 40 domestic water-wells, and these effects are expected to occur beyond the life of the project. As with groundwater discharge to surface water, discussed above, the shallow Fruitland aquifer system should be restored approximately to pre-development groundwater levels. CBM development on all jurisdictions would contribute to these potential effects on domestic water wells.

3.6 Surface Water Resources

3.6.1 Issues

Issue 2: The effects of CBM development on the Project Area's surface water resources?

Numerous issues relating to the potential impacts of CBM development on surface water were identified during the scoping process. These issues are:

- *What are the effects of CBM development on surface water quality?*
- *Will access roads and pipelines degrade water quality?*
- *Will irrigation waters be affected by road and drill pad dust?*
- *How will stormwater runoff be controlled?*
- *Does the process of dewatering the Fruitland reduce surface water flows and affect associated riparian areas/?*
- *What is the interaction between the Fruitland Aquifer and surface water systems after gas production ceases?*
- *To what extent does CBM production result in drying of springs and seeps, located along the Fruitland and Pictured Cliffs outcrops?*
- *How much domestic and irrigation water will be consumed by CBM production during the project and how will that affect current users?*
- *Does further CBM production affect existing surface water rights?*
- *Can produced water reasonably be put to beneficial surface uses rather than injected into deep formations?*

These issues fall into the categories of (1) Water Quality Impacts (Chemical Changes and Physical/Sediment Changes), (2) Surface Water Depletions, and (3) Water Use and Water Rights.

This section evaluates impacts to surface water resources within the Project Area. It also presents the potential impacts that may extend beyond the boundaries of the Project Area for rivers and streams that cross or lie below the Project Area. The criterion used to assess impacts focuses on the potential for changes in water quality or quantity. Measures to mitigate or avoid potential impacts on surface water resources are presented. Direct impacts are defined as effects associated with the activity or disturbance that has an immediate impact on surface water quality or quantity. Examples of direct impacts are sedimentation from erosion during construction of the drill site, pipeline, or road, or contamination that results from spills.

3.6.2 Affected Environment

3.6.2.1 Regional Characterization of Surface Water Hydrology

The climate in the Project Area is semi-arid, with an average annual precipitation of 25 inches. June is the driest month, averaging less than 1 inch of rainfall. Win-

ter precipitation is mostly in the form of snowfall. Seasonal snowpack in the San Juan Mountains can reach 100 inches or more (Kernodle 1996). Spring runoff from the melting snowpack accounts for most of the streamflows within the Project Area and is heaviest in May, June, and July. Local thunderstorms in the summer may result in considerable amounts of rainfall in a short time that may cause flash flooding.

Average data for annual runoff and peak flow have been compiled from USGS stream gauging stations in the vicinity of the Project Area. This information is presented in Table 3-11. USGS gauging stations are illustrated on Figure 3–25.

The Project Area encompasses portions of seven fifth-level watersheds, identified on Figure 3–26. The characteristics of the watersheds within the Project Area are summarized on Table 3-12.

3.6.2.1.1 Middle Animas Valley

The Animas River within the Project Area is generally in good condition. The river has been classified as a “Gold Medal Water” through much of the Project Area and supports healthy trout populations (Japhet 2003). Roads, residences, and commercial development occur all along the river corridor, but primarily on terraces above the river. Approximately 2.9 percent of the watershed has been affected by these high to moderate disturbances. Riparian vegetation exists mainly in the form of willow/box elder/cottonwood stands. The river is stable and water quality is fair to good. Several watersheds of the Animas River were burned during the Missionary Ridge Fire of 2002. Subsequent floods recently introduced large loads of sediment to the river. Future impacts of concern include changes in natural flow regimes from upstream water development, changes in water quality due to stormwater runoff in developed areas, sedimentation from the Missionary Ridge burned area (Burned Area Emergency Response Team [BAER] 2002), future construction and floodplain development, and exotic riparian plant establishment. Existing CBM development is on BLM, private and State jurisdictions. Future CBM development would occur on all three jurisdictions.

Table 3-11 Historical Streamflow at Selected USGS Gauging Stations

	Animas River at Durango, Colorado USGS Station #09361500	Animas River near Cedar Hill, NM USGS Station #09363500	Wilson Gulch near Durango, Colorado USGS Station #09362550	Florida River below Florida Farmer's Ditch USGS Station #09363050	Pine River at Ignacio, Colorado USGS Station #09353800	Piedra River near Arboles, Colorado USGS Station #09349800
Drainage Area (mi^2)	692	1,090	6.5	107.0	340	629
Highest Annual Mean (cfs)[1]	1,489 1941)	1,952 (1941)	1.75 (1997)	118 (1973)	125 (2001)	820 (1979)
Lowest Annual Mean (cfs)[1]	293 (1977)	324 (1977)	0.78 (2000)	4.2 (1977)	30.7 (2000)	92.1 (1977)
Maximum Peak Flow (cfs)[2]	25,000 (10/5/11)	13,100 (6/19/49)	34 (8/6/99)	1,100 (5/19/73)	1,100 (6/12/01)	8,370 (9/6/70)
Minimum Daily Discharge (cfs)[3]	94 (3/2/13)	89 (8/27/02)	0.06 (10/15/00)	0.7 (10/14/68, 10/17/73)	0.33 (8/16/02)	3.9 (8/02)
1 Period of Record	1920–2001	1934–2001	1996–2001	1968–1981	2000–2001	1963–2001
2 Period of Record	1909–2001	1935–1999	1996–2001	1968–1982	1999–2001	1963–2001
3 Period of Record	1897–2002	1933–2002	1995–2002	1967–1982	1999–2002	1962–2002
Source: USGS 2003						
Annual Runoff (acre-feet)[1]	598,400	NA	1.9	NA	58,280	297,600
Source: Crowfoot et al. 2002						

3.6.2.1.2 Lower Florida River

The existing condition of the Florida River through the Project Area is poor, although at this time only 2,644 acres amounting to 3.5 percent of the watershed has undergone a high to moderate disturbance according to the cumulative effects modeling over the area. Natural flow regimes have been disrupted by reservoir-regulated flows, which are not one of the factors for which the watershed impact model accounts. The Missionary Ridge Fire of 2002 burned several Upper Florida River watersheds (BAER 2002). Flooding after the fire introduced tremendous quantities of sediment into the Florida River. The Florida River is heavily utilized for irrigation and other consumptive uses. Drought, low reservoir levels, and other water diversions have periodically left very little water in-channel. A once-thriving fish population has recently been eliminated in many places due to low instream flows, flooding, and sedimentation. Future impacts of concern to the Florida watershed include activities that would add to water shortages or add to the existing sediment load in the river and its tributaries. Existing CBM development has occurred on BLM, private and State jurisdictions. (Figure 2–2, Chapter 2). Future CBM development would occur on all three jurisdictions.

3.6.2.1.3 Lower Los Pinos River Watershed

Smaller sub-watersheds in the Lower Los Pinos River watershed include several intermittent/ephemeral drainages: Ute Creek, Reservoir Canyon, Green Canyon, and Spring Creek in the east. Dry Creek and Homer Canyon are located in the west part of the watershed. The existing disturbance in this watershed is considered low, with only 2.9 percent of the watershed considered highly to moderately impacted by sediment increasing activities at this time.

Existing disturbance in the Spring Creek sub-watershed is low to moderate. This is a stream system prone to flash flooding during intense thunderstorms. Forest Service Road (FSR) 537 and several CBM well access roads are located alongside the drainage and its tributaries. The drainages for Green Canyon, Reservoir Canyon, Ute Creek and its tributary, Ritter Canyon, have low levels of existing disturbance on federal lands. Green Canyon, Ute Creek, and Reservoir Canyon are highly modified by agriculture on private lands. The level of existing disturbance in the lower and upper reaches of Dry Creek is moderate, with several stream crossings and road segments located within the WIZ.

As shown on Figure 3–25, the watershed has a western portion comprised of BLM, private and State jurisdictions and an eastern portion comprised of National Forest and private land (Figure 2–2, Chapter 2). Future CBM development would occur on all four jurisdictions in fairly equal amounts.

3.6.2.1.4 Middle Los Pinos Watershed

The watershed includes the main stem Los Pinos River, a small portion of Bear Creek, and Wallace Gulch, an intermittent tributary. The Pine River within the Project Area is in good to fair condition. The natural flow regime has been disrupted by reservoir-regulated flows. Because water is transferred from Vallecito Reservoir to lands within and south of the Project Area, instream flows tend to be present through this reach. Streamflow is most limiting November through January.

Table 3-12 Characteristics of Watersheds within the Project Area

Watershed	HUC[1] 5	Drainage Area within Project Boundary (mi^2)	Total Drainage Area (mi^2)	Mean Base Elevation within Project Boundary (ft)	Major Rivers	Perennial Tributaries	Intermittent and Ephemeral Tributaries
Lower Florida River	1408010409	34.0	118.8	7,159	Florida		Long Hollow Salt Creek
Middle Animas Valley	1408010407	9.9	109.5	6,906	Animas		
Middle Los Pinos River	1408010115	23.9	86.7	7,352	Pine (Los Pinos River)	Bear Creek	South Fork Texas Creek Wallace Gulch
Beaver Creek	1408010116	43.8	66.1	7,428		Beaver Creek Sauls Creek	Armstrong Canyon Crowbar Creek Hayden Creek Wickensen Gulch
Lower Los Pinos River	1408010117	44.6	171.3	7,428			Dry Creek Homer Canyon Green Canyon Reservoir Canyon Ritter Canyon Salt Canyon Spring Creek Ute Creek Zabel Canyon
Lower Piedra River	1408010205	36.4	104.6	7,477	Piedra River		Blind Gulch Bull Creek Fosset Gulch Goose Creek Ignacio Creek Little Bull Creek Little Squaw Creek Pole Gulch Squaw Creek Sheep Canyon Skull Canyon Turkey Creek Wagon Gulch
Stollsteimer Creek	1408010204	3.2	128.5	6,798		Stollsteimer Creek	Deep Canyon

Notes:
1. HUC = Hydrologic Unit Code
Source: Shafer 2003

The Missionary Ridge Fire of 2002 heavily burned the Middle Los Pinos River-Red Creek, a sixth level watershed, affecting more than 84 percent of the area in this watershed. The same burned area accounts for 27.4 percent of the area in the whole of the Middle Los Pinos watershed. Runoff after the fire introduced tremendous quantities of sediment into the Los Pinos River. The Pine River floodplain through the Project Area has been heavily developed by irrigated agriculture, with scattered gravel pits, roads, CBM wells, and residences present. Commercial and residential development in the floodplain is most dense around the town of Bayfield. Future floodplain development, gravel mining, and increased water diversions are concerns for the health of this stream. Existing CBM development is on BLM, private and State jurisdictions (Figure 2–2, Chapter 2). Future CBM development would occur on all three jurisdictions.

3.6.2.1.5 Beaver Creek

Much of Beaver Creek and its floodplain have been affected by grazing, agriculture, and Highway 160, although only 3.1 percent of the area has been affected by high to moderate disturbances at this time. The stream is in fair to poor condition and instream flows are very low to non-existent at times due to water diversions. The stream has cut down deeply into its floodplain and is a gully for much of its length. Spills from highway accidents, increased water diversions, increased sedimentation, and floodplain developments are concerns to the health of this stream. Existing CBM development is on BLM, National Forest, private and State jurisdictions (Figure 2–2, Chapter 2). Future CBM development would occur on all four jurisdictions in fairly equal amounts.

3.6.2.1.6 Lower Piedra River

The main stem Piedra River within the Project Area is generally in excellent to good condition. Flows on the Piedra River are largely unregulated, and maintain a fairly natural flow regime. With the exception of road construction and scattered agriculture, the river and its floodplain have had limited development. The entire watershed has only 3,603 acres equaling 5.4 percent of high to moderate disturbance. Existing disturbance is low on Bull Creek, Middle Turkey Creek, Lower Goose Creek, Lower Fosset Gulch, Pole Creek, and Little Squaw Creek, the middle and upper reaches of Ignacio Creek, Sheep Canyon, and Blind Gulch.

Moderate to high levels of existing disturbance are observed in the northern and middle part of the watershed on Squaw Creek and lower Wagon Gulch, Little Bull Creek, Upper Goose Creek, Upper Fosset Gulch, and portions of Turkey Creek. All existing CBM development is on National Forest (Figure 2–2, Chapter 2). Future CBM development would occur on all three jurisdictions.

Many watersheds in the HD Mountains are sensitive to erosion due to local geology, sensitive soils, steep slopes, and arid conditions. Destabilization of steep slopes, sedimentation, and floodplain disturbance would be concerns for future development in these watersheds.

3.6.2.1.7 Stollsteimer Creek

Only a small portion of the Stollsteimer Creek watershed is located in the Project Area. The lower section of Stollsteimer to its Piedra River confluence is in fair condition. Agriculture is the main land-use along the Creek. Highway 151 is con-

structed along its length and has modified the floodplain in places. These high to moderate disturbances lead to increases in sediment transported into the stream and cover approximately 6.3 percent of the area of the watershed. Additional disturbances upstream in the watershed (outside the Project Area) may also be contributing sediment. This stream is being monitored and evaluated for listing on the 303(d) list for sediment. Instream flows are very low at times as a result of water diversions. Riparian/floodplain impacts and increased instream water depletions are concerns for the future health of this stream. There is no existing CBM development in Stollsteimer Creek. Future development would be on National Forest.

3.6.2.2 Surface Water Quality — Chemical Contamination as a Result of Spills

3.6.2.2.1 Background

The chemical composition of surface water changes continuously. Most changes are related to the amount and the source of water flowing in a stream at any time. The quality of surface water is directly influenced by geology, climate, and anthropogenic influences in a watershed. Examples of anthropogenic influences could include mining, road construction, stream diversions, agriculture, and other land uses.

One general indicator of water quality is salinity. Salinity refers to the amount of TDS in a water sample and is generally expressed as mg/L of TDS. Electrical conductance (EC) can also be used as a measure of salinity and is considerably easier to measure and monitor. EC values for streams in the vicinity of the Project Area are summarized on Table 3-13. USGS water monitoring stations are plotted on Figure 3–25 to show spatial variability.

The surface water in the Project Area is a calcium-bicarbonate type. Baseline water quality is of neutral to slightly alkaline pH (7.0 to 8.0) with moderate concentrations of TDS. Concentrations of TDS typically are lower in the streams at higher elevations and increase significantly downstream in lowland areas. Agricultural runoff, mining, groundwater inflow, and naturally occurring sediments influence concentrations of TDS. Concentrations of dissolved metals in surface waters in the Project Area are typically low or below the detection limit.

Several studies completed near the Project Area indicate that the quality of surface water may have been affected by diversions for irrigation and associated return flows, runoff from erosive soils, naturally occurring minerals, and mining. BOR has identified parameters in the FEIS for the Animas-La Plata Project that can be associated with these activities, such as selenium, salinity, agricultural pesticides, and sediments. These parameters are indicated as the cause for existing degradation of surface waters in the San Juan River basin (BOR 1996). Existing water quality impairments are discussed below.

3.6.2.2.2 Impaired Water bodies

The quality of water within the Project Area and the cumulative effects area is protected for designated uses in accordance with State of Colorado and the State of New Mexico water quality standards. These uses are set forth in the Colorado Water Quality Control Commission's Classifications and Numeric Standards for

the San Juan River and Dolores River Basins, Regulation No. 34 and in the 2004-2006 State of New Mexico Integrated Clean Water Act Report (New Mexico Water Quality Control Commission 2003). Beneficial designated uses identified for streams in the Project Area include aquatic life (cold 1), primary contact (recreation 1a), water supply, and agriculture (CDPHE 2002a). An assessment of surface water quality in rivers and streams in these basins that encompass the Project Area shows that 95 percent of stream miles assessed are supporting cold-water aquatic life (CDPHE 2002b).

Table 3-13 Water Quality Data from Selected USGS Gauging Stations

Station	Period of Record	Specific Conductance (EC) µmhos/cm	
Animas River at Durango, Colorado USGS Station #09361500	1958, 1971-2001	Mean	434
		Minimum	100
		Maximum	1,010
		# Samples	249
Animas River near Cedar Hill, New Mexico USGS Station #09363500	1933–1999	Mean	467
		Minimum	165
		Maximum	829
		# Samples	105
Wilson Gulch near Durango, Colorado USGS Station #09362550	1995–2001	Mean	613
		Minimum	310
		Maximum	780
		# Samples	38
Florida River below Florida Farmer's Ditch USGS Station #09363050	1976–1982	Mean	253
		Minimum	60
		Maximum	440
		# Samples	70
Pine River at Ignacio, Colorado USGS Station #09353800	1999–2001	Mean	158
		Minimum	80
		Maximum	263
		# Samples	17
Piedra River near Arboles, Colorado USGS Station #09349800	1969–2001	Mean	281
		Minimum	89
		Maximum	570
		# Samples	230

Source: USGS 2003

The State of Colorado 303(d) report for 2004 lists water bodies where water quality is impaired (CDPHE 2002). Currently there are no streams in Colorado within or above the Project Area that are water quality impaired. However, the State of Colorado maintains a Regulation 94, Monitoring and Evaluation List. This list "identifies water bodies where there is reason to suspect water quality problems, but there is also uncertainty regarding one or more listing factors, such as the representative nature of the data." (CDPHE 2006). Stollsteimer Creek above the Southern Ute Boundary is on the Monitoring and Evaluation List for impairment from sediment. This identified stream segment is within the Project Area Boundary

In New Mexico, downstream of the Project Area, the Animas River is listed for impairment because of temperature. Resource extraction is not listed as a cause for the temperature impairment. In 2004, New Mexico removed the listing of the Animas River for sediment.

3.6.2.2.3 Concerns

Surface water quality in the Project Area could be degraded by accidental spills of produced water or drilling fluids. In the event of an accidental release of drilling fluids caused by failure or an overflow of the pit, drilling fluids could traverse the well pad and migrate toward surface drainages. Accidental spills from vehicle refueling operations could affect surface water quality depending on the proximity of water bodies to the refueling locations. In addition, produced water could accidentally spill through a breach in the pipelines. This spill could affect surface water quality near the well sites or along the right-of-way corridors.

There is some concern about water temperatures related to CBM development; however, thermal increases in surface waters caused by CBM development have not occurred in the Project Area and there has been no direct permitted discharge of CBM produced waters to date. Temperatures of thermal springs may increase as a result of CBM development, which could affect the existing temperatures of nearby surface water and potentially alter aquatic habitat. One thermal spring within the Project Area, Hickerson Hot Spring, is discussed along with other effects of CBM development in the following section.

3.6.2.2.4 Effects of CBM Development to Date

Currently, limited data have been collected that correlate changes in the quality of surface water to oil and gas production in the Project Area. Past impaired water quality downstream of the Project Area has been attributed in part to resource extraction and petroleum exploration and production, according to the State of Colorado 1998 305(b) report, and results primarily from sedimentation. Petroleum hydrocarbons have been identified as a constituent of concern; however, information on water quality is insufficient to establish baseline concentrations of petroleum hydrocarbons in streams in the Project Area. Thus, the existing effects of CBM and conventional oil and gas development cannot be assessed.

Trautner et al. (2001) observed changes in water quality and flow at Hickerson Hot Spring that may have been related to a water disposal well located 9 miles south of the spring. The study found that the water temperature of the spring had increased from 90°F in 1990 to 133°F in 1997. In addition, ionic concentrations in the water were observed to have increased significantly over measurements in 1970 (Trautner et al. 2001). Changes in the characteristics of the spring were thought to be caused by increased aquifer pressure from injection of CBM produced water. Water temperature and flow began to decrease when injection at the distant well ceased in 1998 (Trautner et al. 2001). However, the spring water is more similar chemically to other hot springs in the Animas Valley than to injected wastewater despite the coincidental changes at the spring and well (Trautner et al. 2001). This similarity is to be expected; because it is unlikely that the injected produced water was of sufficient volume to displace the natural waters in the fracture system.

The University of New Mexico (UNM) and the New Mexico Ecological Services Office of the U. S. Fish and Wildlife Service (USFWS) conducted a study of waters downstream of the Project Area (BLM et al. 2000). A review of potential water quality contaminants was part of this study, as were investigations for conservation of the native fish population in the San Juan River. The study con-

cluded that the potential exists for oil and gas development to contaminate surface water and groundwater with polycyclic aromatic hydrocarbons (PAHs), hydrocarbons, and salts.

Based on the information gathered for the UNM report, produced water from CBM wells in New Mexico did not contain appreciable amounts of dissolved hydrocarbons as of 1991 (BLM et al. 2000). However, elevated levels of PAHs have been recorded in fish from the SJB with fossil fuels the most likely source of contamination. The BLM Farmington District conducted a separate study to investigate possible sources of PAHs that could be attributed to the federal oil and gas leasing program in New Mexico. Based on data collected from 1994 through 1996, the oil and gas leasing program was not considered responsible for the contribution of PAHs to habitat for the Colorado pikeminnow and razorback sucker via surface water runoff (BLM et al. 2000). The UNM report also indicated a lack of studies (and therefore site-specific data) on degradation in the quality of surface water caused by oil and gas development in the SJB, particularly related to abandoned wells (BLM et al. 2000).

Section 906b(1) of the COGCC Rules and Regulations requires operators to report all spills or releases of exploration and production (E&P) wastes or produced waters that exceed five barrels in volume. As of April 2002, the COGCC database revealed no spills or releases reported from CBM facilities in the Project Area (COGCC 2002a). However, on October 28, 2003, a landowner using a bulldozer hit one of BP America's produced water lines. An estimated 100 barrels of produced water spilled and traveled approximately ⅜ mile down Dry Creek (west of Gem Village and near Highway 160). The water infiltrated the ground. BP is analyzing samples of water; the results are not available to date. Additionally, minor spills or releases of small quantities of drilling fluids, contents of pits, or CBM produced waters were documented, but did not require formal reporting because of the limited volumes.

Operators that store large volumes of oil at CBM facilities are required by Title 40 CFR Part 112 to prepare an SPCC Plan that specifies containment requirements and drainage control measures to prevent any spills from reaching waters of the U.S. No water quality issues from CBM development have been specifically noted in the Project Area, with the exception of accidental discharges of produced water that have apparently resulted in small fish kills in the lower Florida River and its tributary, Salt Creek (Japhet 2002, 2003). These fish kills occurred within the last 10 years; however, no water quality data are available to support these local observations.

3.6.2.3 Surface Water Quality — Physical Changes as a Result of Well Pad, Road, and Pipeline Construction

3.6.2.3.1 Background

Potential impacts to water quality resulting from well pad, road, and pipeline construction include surface erosion and delivery of sediment either directly or indirectly to the stream system.

3.6.2.3.2 Concerns

Stormwater runoff from exposed surfaces can increase streamflow and sediment loads in local drainages. Peak runoff rates can increase as a result of vegetation removal and soil compaction during construction of well pads and access roads. The degree of impact depends on the location of the new facilities and their distance from drainages, rivers and other water bodies. Construction near surface water drainages has the greatest potential to change patterns of streamflow or to alter the channel. Increased runoff and erosion may affect stream channels by increasing bank erosion, channel scour, and sediment loads.

Direct impacts to streams are particularly acute where construction occurs in channels, inside the water influence zone (WIZ), and at sites where roads or pipelines cross perennial streams. The channel may have been altered by road building, bridges, or culverts in these areas, and sediment is easily transported to streams. The existing road network outside of the WIZ may contribute sediment and chemical contaminants either directly into adjacent streams or indirectly by routing water and sediment through ditches and culverts into streams.

Where CBM roads cross steep, landslide-prone areas, mass failures can result. Mass failures are large sources of sediment that may enter streams directly, especially in steep, dissected terrain.

Surface-disturbing activities, such as construction of the well pad, road, and pipeline reduce vegetative cover in the watershed. This loss of cover increases erosion potential and, consequently, sediment loads in surface streams. Additionally, roads and well pads, and the associated traffic, may also increase fugitive dust loading to irrigation water as it flows through open channels and ditches. Although a minor concern, fugitive dust may affect the quality of irrigation water.

Degradation of surface water quality depends on the size of the disturbed area, the topographic controls, the effectiveness of mitigation, and the proximity of the area to surface drainages.

3.6.2.3.3 Effects of CBM Development to Date

Data are not adequate to show conclusively whether erosion caused by CBM operations has altered water quality within the Project Area. Existing CBM activity has likely had little widespread effect on erosion in the Project Area in light of the small amount of disturbed acreage and use of BMPs, which minimize watershed and surface water degradation from well construction and operation. BMPs are listed in Appendix F.

WIZs have been delineated to evaluate the proximity of CBM surface disturbance to surface drainages and water bodies. The WIZ is defined as the zone located on either side of a stream that is 100 feet in width, or the height of the tallest tree, whichever is greater. For this analysis, intermittent and ephemeral streams (2nd order and higher) were assigned a WIZ of 100 feet each side of the stream. Perennial streams (such as Beaver Creek, Sauls Creek, and Stollsteimer Creek) and main stems, such as the Animas, Pine, Florida, and Piedra Rivers, were assigned a WIZ of 300 feet on each side of the stream, because these rivers are large with wider riparian zones. Impacts to water quality and floodplains would be greater within the WIZ because eroded soil would be expected to reach

the drainage and change the quality of the water flowing through the drainage. Construction of roads and well pads within the WIZ often has direct impacts on floodplains and channel function. Table 3-14 summarizes the acres of disturbance from that occurs within the WIZ of the Project Area. Statistics are further broken down by National Forest and BLM jurisdictions.

Table 3-14 Existing Disturbance by Watershed

Watershed	Watershed (Acres)	Existing TOTAL Disturbance (Acres)	Existing TOTAL Disturbance in WIZ[1] (Acres)	Existing Disturbance in WIZ as a Percentage of the existing TOTAL disturbance
Project Area				
Beaver Creek	28,063	330	61	18
Lower Florida River	21,729	359	29	8
Lower Los Pinos River	28,557	296	26	9
Lower Piedra River	23,304	176	42	24
Middle Animas Valley	6,321	88	7	8
Middle Los Pinos River	15,323	234	25	11
Stollsteimer Creek	2,045	7	4	60
Out of Area	NA	8	0	0
Total	125,342	1,496	193	13
National Forest				
Beaver Creek	14,053	161	2	1
Lower Florida River	0	0	0	0
Lower Los Pinos River	12,773	115	0	0
Lower Piedra River	20,424	138	1	1
Middle Animas Valley	0	0	0	0
Middle Los Pinos River	68	0	0	0
Stollsteimer Creek	1,625	4	0	0
Out of Area	NA	0	0	0
Total	49,393	415	3	2
BLM				
Beaver Creek	0	0	0	0
Lower Florida River	2,127	23	1	4
Lower Los Pinos River	2,536	16	0	0
Lower Piedra River	0	0	0	0
Middle Animas Valley	1,670	9	0	0
Middle Los Pinos River	345	2	0	0
Stollsteimer Creek	0	0	0	0
Out of Area	NA	0	0	0
Total	6,678	49	1	2

Note:
1. WIZ = Water Influence Zone

Approximately 193 acres, or 12.9 percent of the surface disturbance from existing CBM development in the Project Area, occurs within the WIZ. Most of this disturbance is a result of road construction. Using the Revised Universal Soil Loss Equation (RUSLE), this existing disturbance corresponds to about 1,640 tons of annual soil loss within the WIZ of the Project Area. The methodology for estimating soil loss using RUSLE is described in detail in the Soils section.

Similarly, approximately 3 acres, or 0.7 percent of the surface disturbance from existing CBM development on National Forest, occurs within the WIZ. Using the RUSLE, this existing disturbance corresponds to about 27 tons of annual soil loss within the WIZ of NFS lands.

On BLM mineral estate (exclusive of National Forest) approximately 1 acre or 2.1 percent of the surface disturbance from existing CBM development occurs within the WIZ. Using the RUSLE, this existing disturbance corresponds to about 3 tons of annual soil loss within the WIZ of BLM lands.

The Forest Service Handbook (FSH 2509.25) 12.1 Standard (3) and Design Criteria 1 specify that actions be allowed in the WIZ only if they "maintain or improve long-term health of the stream and the condition of the riparian ecosystem. Heavy equipment would be kept out of streams, swales, and lakes, except to cross at designated points, to build crossings, or for restoration work. In addition, new concentrated-use sites would be located outside the WIZ if feasible, and should always be located outside riparian areas and wetlands" (FS 2001c).

In addition, the BLM standard for protection of riparian areas applies to federal actions that affect the WIZ identified for this project. The ROD for the amended San Juan RMP states, "For the protection of perennial water impoundments and streams, and/or riparian/wetland vegetation zones, activities associated with oil and gas exploration and development including roads, transmission lines, storage facilities, are restricted to an area beyond the riparian vegetation zone." Adherence to the existing BLM and FS policies and guidelines has minimized impacts to water quality from construction that originates on federal jurisdiction.

The potential for changes in channel morphology and stream health caused by existing CBM development was evaluated by examining the density of roads, the slope gradient, and the proximity to stream channels. This approach provides a quantitative indication of the influence of the existing road system on the hydrologic regime of the watershed and a means for comparing alternatives when impacts are discussed. This information is summarized in Table 3-15, and described below for each of the watersheds in the Project Area.

Table 3-15 Existing Road Density by Watershed

Watershed	Existing Miles of Roads	Existing Road Density1 (mi/mi²)	Existing Roads on Slopes >40 % (mi)	Existing Roads within WIZ (mi)
Beaver Creek[1]	88.5	2.0	0.7	17.7
Lower Florida River	72.3	2.1	0.6	8.6
Middle Los Pinos River	59.7	2.5	0.7	7.0
Lower Los Pinos River	73.6	1.6	3.9	6.5
Lower Piedra River*	55.9	1.5	2.5	13.4
Stollsteimer Creek	2.2	0.7	0.0	1.3
Middle Animas Valley	15.1	1.5	0.8	1.8
Navajo Reservoir Inlet	0.1	7.0	0.0	0.0
Total Density of Project Area	367.1	1.9	9.4	56.5

Note:
1. Note Beaver Creek and Lower Piedra River watersheds are predominantly National Forest. All other watershed have evenly mixed land jurisdictions

3.6.2.3.4 Stormwater Discharge Permits

Currently, the State of Colorado requires that oil and gas operators obtain coverage under the general National Pollutant Discharge Elimination System (NPDES) permit for stormwater discharges during construction. This Construction General Permit requires operators to prepare stormwater management plans. These plans specify BMPs for erosion and sediment control during runoff from disturbed areas to reduce impacts to surface water quality.

The Construction General Permit applies to construction that disturbs more than 1 acre but less than 5 acres. As of June 30, 2005, 1- to 5-acre construction sites associated with oil and gas exploration, production, processing and treatment operations or transmission facilities are required to obtain stormwater permits.

For the oil and gas industry, a "common plan of development" is interpreted to mean "Development of several well pads and/or related infrastructure (i.e., roads, pipelines, pumping stations, etc) in a contiguous area either during the same time period or under a consistent plan for long-term development…" (CDPHE 2003). Contiguous is currently defined as sites that are up to ¼ mile apart or when the areas between are connected by site disturbance. Therefore, each company involved in oil and gas development within the Project Area is required to obtain a Construction General Permit for the larger common plan of development.

Currently, there are six active stormwater permits for oil and gas facilities in the Project Area (Bagan 2003). All of these facilities are located in La Plata County. Examples of BMPs that operators have incorporated into the stormwater management plans include installation of silt barriers (silt fences and hay bales) and construction of berms, water bars, and culverts to divert water away from the disturbed area.

Pipeline routings and roads that cross stream drainages and waterways are further regulated by U.S. Army Corps of Engineers (USACE) Section 404 permits under the CWA to prevent discharges of sediment to state waters during construction.

3.6.2.4 CBM Development on Irrigation Water Quality and Fugitive Dust

3.6.2.4.1 Background

The majority of the surface water resources in the Project Area are used for irrigation. Diversion ditches and distribution canals may be found near proposed well pads and access roads.

3.6.2.4.2 Concerns

Irrigation waters conveyed in open channels adjacent to heavily traveled roads with a native surface might be affected by dust. Any surface-disturbing activity that reduces vegetative cover in the watershed, such as construction of well pads or roads, can increase emissions of fugitive dust. These emissions in turn influence concentrations and loads of sediment to surface waters used for irrigation.

3.6.2.4.3 Effects of CBM Development to Date

Where fugitive dust settles on surface water bodies that are adjacent to heavily traveled roads with a native surface, minor increases in sediment loads to these drainages are likely. State water quality standards for the protection of agricultural use (for example, irrigation) do not include standards for total suspended solids (TSS); however, water bodies designated for additional uses may be affected by increases in TSS. Existing impacts have been reduced by locating well pads and roads away from open channels and irrigation diversions and using dust inhibitors on the surfaces of roads that could cause emissions of fugitive dust.

3.6.2.5 Fruitland Dewatering in Relation to Surface Water Flows and Associated Riparian Areas, Wetlands, and Springs and Seeps

3.6.2.5.1 Background

In the Project Area, groundwater discharges to the surface where stream crossings intersect the outcrop of the Fruitland Formation. Groundwater contributions of the Fruitland Formation to flows in the Animas, Pine, and Florida Rivers are minimal (less than 1 percent) when compared with base flows (AHA 2000). Base flows in these streams result primarily from groundwater discharge from other formations.

Total recharge to the Fruitland Formation in the Colorado portion of the SJB was estimated during the 3M study to be approximately 208 acre-feet/year (AHA 2000, Questa 2000).

The outcrops of the Fruitland Formation and Pictured Cliffs Sandstone typically do not support riparian habitat. However, springs and seeps situated along the outcrop may support wetland or riparian vegetation. Figure 3–27 shows springs and seeps within the Project Area and in the vicinity of the Project Area that occur along the outcrop.

Within the Project Area, riparian vegetation is generally limited to the immediate vicinity of the larger rivers, such as the Animas, Florida, Pine, and Piedra. However, riparian vegetation is along the perennial streams, such as Beaver Creek, Sauls Creek, and Stollsteimer Creek, and intermittent channels, such as Dry Creek and Lange Canyon. Wetlands within the Project Area are generally concentrated near the larger rivers and some perennial streams. Some wetlands occur along the outcrop in association with seeps and springs; others are found scattered throughout the Project Area.

3.6.2.5.2 Concerns

The Fruitland Formation and Pictured Cliffs Sandstone are in direct hydraulic communication with the river and alluvial fill aquifer system (Cox et al. 2001). Groundwater flows from the recharge areas along the high-elevation ridges of the outcrop, to discharge areas at the river cuts. Before CBM development in the NSJB, discharge from the Fruitland aquifer to the Animas, Florida, Pine, and Piedra Rivers totaled approximately 194 acre-feet/year. Modeling by Cox et al. (2001) has demonstrated that CBM development has and will continue to intercept groundwater that would normally discharge to these rivers, all located in the Project Area.

Riparian and wetland areas associated with these streams could be affected by depletions in surface flows and groundwater discharge. Additionally, springs and seeps along the outcrop could be affected by CBM development on all jurisdictions as a result of the interception of groundwater that would typically discharge at these springs and seeps. CBM development on all jurisdictions within the Project Area would increase the drawdown of shallow groundwater resources along the outcrop of the Fruitland Formation, potentially drying up springs and seeps by lowering the water table.

3.6.2.5.3 Effects of CBM Development to Date

The nearest existing CBM well is located more than ¼ mile away from seeps and springs identified along the outcrop. The precise impact of the proximity of a well to seeps and springs is not known; however, site-specific monitoring of seeps and springs along the outcrop has been initiated in the fall of 2005 and will continuously evaluate impacts from CBM development. Expansion of the number of monitoring sites will continue in 2006. Some relocation or realignment during siting of existing facilities during the APD stage to avoid construction near seeps and springs has helped in reducing potential impacts to date.

Dewatering of the Fruitland Formation as a result of existing CBM development has not been documented to dry up springs and seeps in the Project Area (Janowiak 2002). However, cases have been documented south of the Project Area where springs have dried up and shallow water wells have been dewatered by CBM development.

To date, 65 acre-feet/year is depleted from surface flows in the Animas, Pine, and Florida Rivers in the NSJB (Cox et al. 2001). Figure 3–28 illustrates current depletions (without infill wells) in surface flows in these rivers. To date, CBM development has not affected surface flows in the Piedra River. Surface flow depletions are a cumulative result of CBM wells developed on all jurisdictions within

the Project Area. Because, no distinction can be made regarding the relative effect of drilling on each of the four jurisdictions that contribute to depletion of surface flows, CBM development in total is treated as an aggregate causative factor within the Project Area.

Depletions of surface water are expected to peak between 2025 and 2075 and continue beyond the life of the project, likely for several centuries, or until the Fruitland aquifer is recharged (Cox et al. 2001). The interaction between surface flows and the Fruitland aquifer would return to pre-CBM development conditions if the aquifer is recharged.

Riparian and wetland areas near the larger rivers have not likely been affected by CBM development. The depletions in surface flows are low when compared with baseflows in these rivers, and no direct impacts have been documented to these areas to date.

3.6.2.6 Consumptive Water Uses, Water Rights, and CBM Well Production

3.6.2.6.1 Background

CBM development consumes water through two primary means. First, fresh water is required to drill a well. Second, dewatering the Fruitland Formation to extract CBM gas disrupts the natural recharge of surface water in springs, seeps, and rivers at the Fruitland outcrop. This disruption is an indirect consumption of surface water.

The total surface water withdrawals for the counties that encompass the Project Area equaled 421.7 million gallons per day (mgd) in 1995 (USGS 1995). Table 3-16 summarizes the total water use within La Plata and Archuleta Counties in 1995 (USGS 1995). Irrigation uses the vast majority of surface water consuming about 97 percent of surface water withdrawals (410 mgd) (USGS 1995).

Table 3-16 Surface Water Use by County, 1995

Category	La Plata (mgd)[1]	Archuleta (mgd)[1]	Total (mgd)[1]
Public Supply	5.49	1.77	7.26
Commercial	0.01	0.00	0.01
Domestic	0.00	0.00	0.00
Industrial	0.05	0.00	0.05
Mining	0.02	0.00	0.02
Livestock	4.22	0.11	4.33
Irrigation	364.75	45.30	410.05
Total	374.54	47.18	421.72

Note:
1. mgd = millions of gallons per day

Major communities located in or near the Project Area that use surface water resources as municipal supplies include the towns of Bayfield and Ignacio in Colo-

rado and the Jicarilla Apache Tribe in Dulce, New Mexico. Estimated populations served are 1,800 in Bayfield, 845 in Ignacio, and 1,800 for the Jicarilla. Approximately 6,400 people obtain drinking water from groundwater collectively in the two counties of interest, and 26,730 people draw drinking water from surface water resources (USGS 1995).

The Colorado Division of Water Resources (CDWR) administers water used in the State of Colorado through a system of water rights. A water right (or appropriation) is the right to divert the public waters of the state and put them to beneficial use. The project is located within Colorado Water Division 7.

Surface water rights filed in Division 7 are shown on Figure 3–29. Most of the water rights have multiple beneficial uses. A total of 317.6 cubic feet per second (cfs) and 728.3 acre-feet/year have been adjudicated within the Project Area. The adjudication does not necessarily reflect the amount of water available in any year for the intended uses; instead, it is only a representation of legal claims to the water in a specific stream course.

3.6.2.6.2 Concerns

Development of CBM requires fresh water to drill and complete wells. CBM operators would purchase water from existing users or apply to the Colorado State Engineer's Office (SEO) for appropriation of water rights. This requirement could affect available water supplies that are used under existing water rights.

There is concern that CBM development may also affect existing water rights by intercepting water that would otherwise be available as springs, domestic wells, or instream flow. Many of the streams in the Project Area are over-appropriated during the irrigation season; depletions from CBM development during this time could affect existing water users.

3.6.2.6.3 Effects of CBM Development to Date

CBM well drilling and completion requires approximately 0.3 acre-feet of fresh water per well. Most of this water is either purchased from a private source (such as landowners with existing surface water rights) or is purchased and trucked in from a local supply. CBM well drilling could shift the amount of consumptive use from irrigation, domestic supply or other beneficial uses, to use for industrial/mining purposes to satisfy this requirement for water. To date, CBM well drilling for well completion has generally had minimal effects on consumptive use of surface waters in the Project Area.

Existing CBM development is dewatering the Fruitland Formation, causing a loss of surface water to the streams and rivers in the analysis area. As of 2001, it has been estimated that 65 acre-feet per year are currently being depleted from the Animas, Florida, and Pine Rivers (Cox et al. 2001). Because many of the streams in the Project Area are over-appropriated during the irrigation season, loss of water due to CBM development during this time has the potential to affect existing water users.

Over-Appropriated Streams

CDWR maintains a list of streams located within Water Divisions of the state that have historically required administration to meet demands by senior water rights, or where water is not adequate during limited periods to meet the needs of the water rights that already have been established. The Project Area is located within Water Division 7, which lists nine districts where streams are over-appropriated. Table 3-17 identifies streams within or adjacent to the Project Area that CDWR considers over-appropriated, that require administration, or that are unable to meet water rights demands.

Table 3-17 State of Colorado, Water District 7 Over-Appropriated Streams In or Near the Project Area

District	Stream	Location	ID	Legal Description	Comment
30	Spring Creek	Above the Macy Ditch	593	SE¼, SE¼, Sec. 10, T35N, R9W	Upstream of the Project Area
	Florida River	Above Banks-Tyner Ditch	1,033	SE¼, NW¼, SE¼ of Sec. 16, T34N, R8W	Within Project Area
31	Pine River	Above Spring Creek Ditch	509	NE¼, NE¼, SE¼ of Sec. 15U, T34N, R7W	Within Project Area
	Wallace Gulch	Above the Colorado SW Ditch #2	709	SW¼, NE¼ of Sec. 33, T35N, R7W	Within Project Area
	Beaver Creek	Above Citizens Ditch	569	NW¼, NE¼ of Sec. 24, T35N, R6W	Within Project Area
78	Devil Creek	Above the Ford Ditch	NA[1]	SW¼ of Sec. 12, T34N, R4W	Northeast of the Project Area, stream drains to the Piedra River
	Stollsteimer Creek	Above Dike Ditch #2	539	NW¼, SE¼ of Sec. 9, T34N, R3W	Stream drains to the Project Area
Other	Florida River	NA	NA	NE corner of Sec. 12, T34N, R9W	Within Project Area

Note:
1. NA = not available
Source: Beegles 1993

Loss of surface water that results from dewatering the Fruitland Formation during CBM development is most problematic in over-appropriated streams. Surface water depletions caused by CBM operations have the highest risk of affecting existing water rights during periods when there is not enough water present. Surface water shortages occur most commonly during the irrigation season.

3.6.2.7 Beneficial Use of CBM Produced Waters

3.6.2.7.1 Background

Water produced from CBM dewatering of the Fruitland Formation (through December 1998) totaled 244 million barrels, or 28,900 acre-feet (Questa 2000). The Fruitland Formation is a regional aquifer with marginal to poor water quality (1,000 to 10,000 mg/L TDS) and low yields (Cox et al. 2001). The potential for beneficial use of CBM produced water would depend on the quality of the groundwater extracted from the coals in the Fruitland Formation and the potential use of the water. The suitability of CBM produced water for surface discharge and the limitations on use based on water quality would be established in site-specific discharge permits.

3.6.2.7.2 Concerns
Some CBM operators are investigating surface discharge of produced water. The quality of the produced water when compared with effluent limitations and water quality standards for the receiving streams would control whether surface discharge would be allowed. Produced water would likely require treatment to meet water quality standards. If an energy company were to put produced water to beneficial use, they would be required to obtain a water right from CDWR.

3.6.2.7.3 Effects of CBM Development to Date
CBM produced water has not been discharged to the surface, so there are no environmental effects to date. CBM produced water was used in a limited capacity to support emergency firefighting near the Project Area during summer 2002. At that time, 3,500 barrels of produced water from BP-America's operation was transported to a staging area for use on the Missionary Ridge fire near Durango (Baldwin 2002).

3.6.3 Environmental Consequences

CBM impacts to surface waters would occur in, as well as downstream of, the Project Area under all alternatives. Existing and proposed well pads, roads, and pipelines, were evaluated to assess the potential environmental consequences to surface water resources. Short-term impacts would occur during the construction, drilling, and completion phases. Long-term impacts would occur during the production and maintenance, decommissioning, and reclamation phases.

3.6.3.1 Surface Water Quality — Chemical Contamination as a Result of Spills

The potential for contaminant spills is directly correlated to the amount and location of development that takes place in each alternative. The potential for spills to reach water bodies is a function of proximity to streams.

3.6.3.1.1 Alternative 1 — Proposed Action
Potential short-term impacts to surface water quality could occur as a result of accidental spills of fuel, lubricants, and fluids during construction of the well pads, associated facilities, roads, and pipelines. Long-term impacts over the life of the project could occur from leaks or breaks in the pipelines that run from the wells to the disposal facilities. During operations, produced water could spill through a breach in the pipelines that convey the water to disposal facilities. Spills could affect surface water quality near injection wells or along the ROW corridors.

Long-term risk of chemical contamination would be highest in areas where produced water pipelines cross existing landslides or landslide hazard areas. If new construction were to trigger any movement of landslides, pipelines could either rupture and leak, or break and spill large quantities of wastewater on the landscape or into Project Area streams. Leaking pipelines could also saturate the ground causing more landslide movement and additional damage due to ruptured pipelines. Depending on the location, leaks or catastrophic pipeline failures could

take many hours to reach and repair, allowing spills to cause much erosion and chemical contamination damage to the environment.

Alternative 1 involves construction of 18.9 miles of pipeline on landslide hazard areas or pre-existing landslides, of which 14.2 miles of new pipeline are proposed on National Forest in the Lower Piedra watershed. This watershed is remote, steep, potentially unstable, and dissected by numerous streams. Consequently, there is high risk that pipeline construction across the landslide hazard areas could result in produced water spills that could reach streams. The associated risk that water quality standards could be violated as a result of chemical contamination is also high in Alternative 1.

If a pipeline ruptures, short-term increases in salinity would likely occur in adjacent surface waters. Emergency response procedures would be implemented in the event of pipeline failure.

Operators use pits to contain drilling fluids during drilling and completion. These pits could fail or overflow, allowing drilling fluids to traverse the well pad and flow into surface drainages. Effects to water quality would depend on the location of the pit in relation to surface drainages, as well as on the amount of fluids released and the adequacy of spill containment and cleanup procedures. Detailed design of well pads, pipelines, and roads as well as spill contingency plans would be completed during the site-specific analysis on federal jurisdiction during the APD stage of planning.

Vehicle refueling areas could also provide a source of contamination to the quality of surface water. These effects would be minimized on federal lands by locating refueling stations away from surface drainages and water bodies and storing fuels in bermed areas. Watershed conservation practices require that new sources of chemical pollutants be kept where they would not reach surface waters. The requirement would be met by relocating the well pads outside the WIZ, where possible (FS 2001c). New sources of pollutants would also be isolated from surface waters by installing contour berms and trenches around vehicle refueling areas (FS 2001c).

Construction would require certification under the NPDES general permit, and materials handling and spill prevention procedures would be implemented to contain spills before they could reach surface waters. The companies would also develop site-specific SPCC plans for construction and operation of the facilities to be located on each well pad. These regulatory processes and BMPs would be implemented on National Forest and BLM lands to minimize impacts to surface water quality from potential spills and leaks. Therefore, the potential for spills and leaks to reach surface water bodies would be long term but minor.

Alternative 1 CBM development could result in contaminant spills anywhere throughout the Project Area. Short-term risk would be highest during the construction phase of wells located in the WIZ (Table 3-19 shows the acres of WIZ affected by jurisdiction). If a flood event were to occur while drilling in the floodplain, water may overtop or damage containment berms allowing drilling fluids to enter streams. Drilling outside spring runoff periods or monsoon flood season when conditions are saturated could decrease the risk of flood damage and

spills (see Mitigation section). Alternative 1 proposes numerous wells in floodplain areas.

Overall, the long-term probability of spills associated with Alternative 1 is anticipated to be high because of the large amount of pipeline construction in landslide hazard zones, primarily on National Forest. CBM development would be subject to federal and state regulations for the protection of water quality standards. There is an associated long-term risk that water quality standards could be violated as a result of chemical contamination from spills.

3.6.3.1.2 Alternative 2

Alternative 2 would result in the highest level of development and; consequently, the potential for effects to surface water quality from spills of petroleum or CBM produced waters would be much greater than described for Alternative 1. Alternative 2 involves constructing 41.9 miles of pipeline across high landslide hazard areas. Beaver Creek (9.7 miles), Lower Los Pinos (8.4 miles), and Lower Piedra (18.3 miles) watersheds would have the highest risk of impact due to the large amount of proposed pipeline construction across landslide hazard areas in these watersheds.

3.6.3.1.3 Alternative 5 — No Action

Alternative 5's potential for spills of petroleum or CBM produced waters would be slightly lower than under Alternative 1 in the western Project Area because no wells would be developed on BLM mineral estate. In the eastern Project Area, no wells would be developed on federal leases on National Forest. Thus, the potential for spills on National Forest would be much lower than Alternative 1. The low number of wells in the eastern Project Area results in the lowest potential risk of impacts to surface water quality from spills among the alternatives. Drilling would, however, continue on private and state leases, where spills of produced water or drilling fluids could occur and affect surface waters in the Project Area. Alternative 5 would involve constructing 3.0 miles of pipeline through landslide hazard areas.

3.6.3.1.4 Alternative 6

The potential for spills of petroleum or CBM produced waters would be the same as Alternative 1 in the western Project Area and much lower than Alternative 1 in the eastern Project Area on National Forest. Fewer wells, and pipelines overall would be constructed as compared to Alternative 1 because construction would not be authorized in the HD Mountains Roadless Area, which has some of the steepest and most environmentally sensitive areas within the Project Area, or within 1.5 miles of the Fruitland Outcrop. Alternative 6 does involve constructing wells and pipeline proximal to some streams where spills of produced water or drilling fluids could affect surface waters in the Project Area, but there are fewer of these areas compared to Alternative 1. (See Table 3-18 through Table 3-23 and the relative difference between WIZ impacts by alternative and jurisdiction). Alternative 6 involves 3.8 miles of pipeline construction through landslide hazard areas.

3.6.3.1.5 Alternative 7

The potential for spills of petroleum or CBM produced waters would be the same as Alternative 1 in the western Project Area and potentially lower than Alternative 1 in the eastern Project Area due to avoidance of areas of high slope instability. Under Alternative 7, three areas of existing landslides and landslide hazard would not be developed on National Forest in the HD Mountains so fewer wells overall would be constructed as compared to Alternative 1. These areas are upper and lower Ignacio Creek area, the area south of the Rock Bridge, and the area south of the Relay Tower (See Figure 2–6 Alternative 7 and Figure 3–14 depiction of landslide hazard areas.) Alternative 7 would still involve well construction proximal to some streams where spills of produced water or drilling fluids could affect surface waters in the Project Area (Table 3-18 to Table 3-23).

A total of nine miles of pipeline would be built over landslide hazard areas or pre-existing landslides, mostly on National Forest. The largest amount of new pipeline would be on National Forest in the Lower Piedra watershed (6.1 miles). This watershed is very remote, steep, potentially unstable, and dissected by numerous streams. Consequently, there is high risk that road and pipeline construction across the landslide hazard areas could result in hazardous chemical spills that would reach streams. The associated risk that water quality standards could be violated as a result of chemical contamination is also high as a result of Alternative 7, but lower than Alternatives 1 and 2.

3.6.3.2 Surface Water Quality — Physical Changes as a Result of Well Pad, Road, and Pipeline Construction

Surface erosion and sediment delivery either directly or indirectly to the stream system is a potential consequence of well pads, roads, and pipeline construction. Direct effects would occur if sediment were transported to surface water drainages and water quality impairment occurred. Modification of floodplains due to facility construction in the WIZ is another direct effect of concern. Indirect effects include alteration of channel morphology as a result of scour and deposition, channel instability, and development within floodplains. Large increases of sediment could force adjustments to the channel as streams reestablish equilibrium between discharge, increased sediment load, and channel morphology. Channel adjustments could result in loss of floodplains, aquatic habitat, and riparian habitat. These potential impacts are analyzed in detail below.

Indicators of direct impacts are presented in Table 3-18 through Table 3-23. These tables summarize the short- and long-term disturbance by watershed resulting from CBM construction and production activities that would occur within the WIZ.

Table 3-18 Short-term Total Disturbance by Watershed for all Alternatives

Watershed	Acres in watershed	Alternative (acres) 1	2	5	6	7
Project Area						
Middle Los Pinos River	15,323	65.0	122.4	61.8	63.6	65.0
Beaver Creek	28,063	149.4	386.6	59.3	120.3	124.6
Lower Florida River	21,729	53.0	137.7	44.4	50.0	53.0
Stollsteimer Creek	2,045	40.2	61.3	0.2	0.2	36.1
Middle Animas Valley	6,321	13.4	71.4	13.4	13.4	13.4
Lower Piedra River	23,304	477.9	590.6	116.4	183.1	317.7
Lower Los Pinos River	28,557	202.8	366.0	89.7	176.9	190.3
Total	125,342	1,001.7	1,736.0	385.2	607.5	800.1
National Forest						
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Beaver Creek	28,063	98.1	270.0	4.9	68.0	72.8
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	39.0	52.2	0.02	0.0	34.8
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	453.2	539.7	100.6	164.7	293.8
Lower Los Pinos River	28,557	110.7	266.5	2.0	84.9	98.2
Total	125,342	701.0	1128.4	107.52	317.6	499.6
BLM						
Middle Los Pinos River	15,323	8.4	18.9	2.6	7.0	8.4
Beaver Creek	28,063	2.6	5.2	2.6	2.6	2.6
Lower Florida River	21,729	16.4	51.5	7.8	13.4	16.4
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	24.0	0.0	0.0	0.0
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	35.6	35.3	10.4	35.6	35.6
Total	125,342	63.0	134.9	23.4	58.6	63.0

Totals for short-term disturbance include acreages of disturbance predicted from windows for yet-undetermined road locations.

Table 3-19 Short-Term Total Disturbance in WIZ

Watershed	Acres in watershed	Alternative (acres) 1	2	5	6	7
Project Area						
Middle Los Pinos River	15,323	7.8	13.1	7.8	7.8	7.8
Beaver Creek	28,063	11.5	34.6	10.8	13.0	11.5
Lower Florida River	21,729	5.6	13.4	2.6	2.6	5.6
Stollsteimer Creek	2,045	4.1	8.1	0.0	0.0	3.5
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	55.4	59.6	23.1	27.2	39.0
Lower Los Pinos River	28,557	8.7	35.5	5.2	8.7	8.7
Total	125,342	93.1	164.3	49.5	59.3	76.1
National Forest						
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Beaver Creek	28,063	0.6	15.9	0.0	2.2	0.6
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	4.1	5.5	0.0	0.0	3.5
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	50.2	51.8	19.6	23.7	34.0
Lower Los Pinos River	28,557	3.5	30.3	0.0	3.5	3.5
Total	125,342	58.4	103.5	19.62	29.4	41.6
BLM						
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Beaver Creek	28,063	2.6	2.6	2.6	2.6	2.6
Lower Florida River	21,729	3.0	3.0	0.0	0.0	3.0
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	2.6	2.6	2.6	2.6	2.6
Total	125,342	8.2	8.2	5.2	5.2	8.2

Totals for short-term disturbance include acreages of disturbance predicted from windows for yet-undetermined road locations.

Table 3-20 Short-Term Disturbance in WIZ as a Percentage of the Total Short-Term Disturbance

Watershed	Acres in watershed	Alternative (percent) 1	2	5	6	7
Project Area						
Middle Los Pinos River	15,323	12.0	10.7	12.7	12.3	12.0
Beaver Creek	28,063	9.2	8.9	18.3	10.8	9.2
Lower Florida River	21,729	10.6	9.8	5.9	5.2	10.6
Stollsteimer Creek	2,045	10.3	1.3	1.2	0.0	9.7
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	11.6	10.1	20.0	14.9	12.3
Lower Los Pinos River	28,557	4.3	9.7	5.8	4.9	4.6
Total	125,342	9.3	9.3	12.9	9.8	9.5
National Forest						
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Beaver Creek	28,063	1.0	5.9	0.0	3.2	1.0
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	10.5	10.5	100.0	0.0	10.1
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	11.1	9.6	19.5	14.4	11.6
Lower Los Pinos River	28,557	3.2	11.4	0.0	4.1	3.6
Total	125,342	8.3	9.2	18.3	9.3	8.3
BLM						
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Beaver Creek	28,063	100.0	50.0	100.0	100.0	100.0
Lower Florida River	21,729	18.3	5.8	0.0	0.0	18.3
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	7.3	7.4	25.0	7.3	7.3
Total	125,342	13.0	6.1	22.2	8.9	13.0

Totals for short-term disturbance include acreages of disturbance predicted from windows for yet-undetermined road locations.

Table 3-21 Long-term Total Disturbance by Watershed for all Alternatives

Watersheds	Acres in Watershed	Alternative (acres) 1	2	5	6	7
Project Area						
Beaver Creek	28,063	101.4	258.8	41.5	86.5	85.7
Lower Florida River	21,729	35.9	93.0	29.9	33.9	35.9
Lower Los Pinos River	28,557	139.1	248.0	61.3	126.2	130.9
Lower Piedra River	23,304	304.2	379.0	72.6	121.4	207.5
Middle Animas Valley	6,321	10.0	48.9	0.0	10.0	10.0
Middle Los Pinos River	15,323	45.0	83.7	42.7	44.0	45.0
Stollsteimer Creek	2,045	24.5	38.7	0.0	0.0	24.5
Total	125,342	660.1	1,150.1	248.0	422.0	539.5
National Forest						
Beaver Creek	28,063	65.8	179.2	3.8	50.3	49.7
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	76.9	180.7	2.0	64.0	68.7
Lower Piedra River	23,304	288.7	346.0	62.4	109.9	192.1
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	23.8	32.7	0.02	0.0	23.8
Total	125,342	455.2	738.6	68.22	224.2	334.3
BLM						
Beaver Creek	28,063	1.8	3.5	1.8	1.8	1.8
Lower Florida River	21,729	11.3	34.9	5.3	9.3	11.3
Lower Los Pinos River	28,557	24.0	23.8	7.0	24.0	24.0
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	16	0.0	0.0	0.0
Middle Los Pinos River	15,323	5.8	12.8	1.8	4.8	5.8
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Total	125,342	42.9	91.0	15.9	39.9	42.9

Totals for long-term disturbance include acreages of disturbance predicted from windows for yet-undetermined road locations.

Table 3-22 Long-Term Total Disturbance in WIZ

Watersheds	Acres in Watershed	Alternative (acres) 1	2	5	6	7
Project Area						
Beaver Creek	28,063	8.7	24.0	8.3	10.4	8.7
Lower Florida River	21,729	3.8	9.0	1.8	1.8	3.8
Lower Los Pinos River	28,557	5.7	23.4	3.5	5.7	5.7
Lower Piedra River	23,304	35.0	37.8	14.4	17.1	25.8
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	5.3	23.4	5.3	5.3	5.7
Stollsteimer Creek	2,045	2.2	5.0	0.0	0.0	2.2
Total	125,342	60.7	122.6	33.3	40.3	51.9
National Forest						
Beaver Creek	28,063	0.4	10.5	0.0	2.1	0.4
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	2.2	19.8	0.0	2.2	2.2
Lower Piedra River	23,304	31.6	32.7	12.0	14.6	22.5
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	2.2	3.2	0.02	0.0	2.2
Total	125,342	36.4	66.2	12.02	18.9	27.3
BLM						
Beaver Creek	28,063	1.8	1.8	1.8	1.8	1.8
Lower Florida River	21,729	2.0	0.0	0.0	0.0	2.0
Lower Los Pinos River	28,557	1.8	1.8	1.8	1.8	1.8
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Total	125,342	5.6	3.6	3.6	3.6	5.6

Totals for long-term disturbance include acreages of disturbance predicted from windows for yet-undetermined road locations.

Table 3-23 Long-Term Disturbance in WIZ as a Percentage of the Total Long-Term Disturbance

Watersheds	Acres in Watershed	Alternative (percent) 1	2	5	6	7
Project Area						
Beaver Creek	28,063	8.6	9.3	20.0	12.0	10.1
Lower Florida River	21,729	10.5	9.7	5.9	5.2	10.5
Lower Los Pinos River	28,557	4.1	9.4	5.7	4.5	4.4
Lower Piedra River	23,304	11.5	10.0	19.8	14.1	12.4
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	4.1	10.5	12.3	12.0	11.7
Stollsteimer Creek	2,045	9.0	12.8	100	0.0	8.9
Total	125,342	9.2	10.7	13.4	9.5	9.6
National Forest						
Beaver Creek	28,063	1.0	5.9	0.0	4.2	1.0
Lower Florida River	21,729	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	28,557	2.9	11.0	0.0	3.4	3.2
Lower Piedra River	23,304	11.0	9.5	19.2	13.3	11.7
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	8.5	9.2	100.0	0.0	9.2
Total	125,342	18.7	47.8	17.6	8.4	8.2
BLM						
Beaver Creek	28,063	100.0	51.4	100.0	100.0	100.0
Lower Florida River	21,729	17.7	0.0	0.0	0.0	17.7
Lower Los Pinos River	28,557	7.5	7.6	25.7	7.5	7.5
Lower Piedra River	23,304	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	6,321	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	15,323	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	2,045	0.0	0.0	0.0	0.0	0.0
Total	125,342	13.1	4.0	22.6	9.0	13.1

Totals for long-term disturbance include acreages of disturbance predicted from windows for yet undetermined road locations.

Table 3-24 through Table 3-28 summarize road density, road construction on steep slopes, proximity of new roads to the WIZ and the estimated number of new stream crossings by alternative.

Within each alternative, there are two levels of location detail. There are 56 access roads and well locations where roads and well pads have been staked and the exact location of the facilities are known. Within these staked locations, siting adjustments have been made to avoid sensitive environmental conditions where feasible. The non-staked locations have not been field verified, and actual final siting will not occur until the companies submit notices of staking (NOSs) or APDs for the locations. These non-staked locations present conceptual approximations of the best facility location based upon field knowledge, topographic map aids, and the application of well spacing rules. During the field onsites, well locations will be adjusted to best avoid environmental hazards, and exception

locations may be utilized that move wells out of the spacing windows for such purpose. Environmental consequences have been based on mapped locations, but the environmental consequences described should be conditioned by the assumption that some areas of concern can be avoided through careful road and well siting and utilization of engineering designs that reduce hazardous impacts.

Table 3-24 Miles of Road (Proposed) by Watershed for All Alternatives

	Alternative (mi)				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	15.64	44.39	5.43	12.04	13.08
Lower Florida River	4.58	12.82	4.25	4.25	4.58
Lower Los Pinos River	21.00	41.67	8.00	16.68	19.07
Lower Piedra River	65.33	78.77	18.68	25.86	43.94
Middle Animas Valley	1.00	6.89	1.00	1.00	1.00
Middle Los Pinos River	5.58	11.08	5.50	5.58	5.58
Stollsteimer Creek	4.78	6.82	0.01	0.00	4.79
National Forest					
Beaver Creek	11.14	33.64	0.59	7.35	8.49
Lower Florida River	0.00	0.00	0.00	0.00	0.00
Lower Los Pinos River	12.69	32.69	0.00	8.37	10.76
Lower Piedra River	61.53	72.46	16.29	23.06	40.16
Middle Animas Valley	0.00	0.00	0.00	0.00	0.00
Middle Los Pinos River	0.00	0.00	0.00	0.00	0.00
Stollsteimer Creek	4.56	5.84	0.00	0.00	4.55
BLM					
Beaver Creek	0.25	0.50	0.25	0.25	0.25
Lower Florida River	1.08	4.57	0.75	0.75	1.08
Lower Los Pinos River	3.31	3.23	1.00	3.31	3.31
Lower Piedra River	0.00	0.00	0.00	0.00	0.00
Middle Animas Valley	0.00	2.64	0.00	0.00	0.00
Middle Los Pinos River	0.58	1.58	0.25	0.58	0.58
Stollsteimer Creek	0.00	0.00	0.00	0.00	0.00

Table 3-25 Increase in Road Density (Proposed) by Watershed for All Alternatives

	Alternative (mi/mi²)				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	0.4	1.0	0.1	0.3	0.3
Lower Florida River	0.1	0.4	0.1	0.1	0.1
Lower Los Pinos River	0.5	0.9	0.2	0.4	0.4
Lower Piedra River	1.8	2.2	0.5	0.7	1.2
Middle Animas Valley	0.1	0.7	0.1	0.1	0.1
Middle Los Pinos River	0.2	0.5	0.2	0.2	0.2
Stollsteimer Creek	1.5	2.2	0.0	0.0	1.5
National Forest					
Beaver Creek	0.3	0.8	0.0	0.2	0.2
Lower Florida River	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	0.3	0.8	0.0	0.2	0.2
Lower Piedra River	1.7	2.0	0.5	0.6	1.1
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	1.4	1.8	0.0	0.0	1.4
BLM					
Beaver Creek	0.0	0.0	0.0	0.0	0.0
Lower Florida River	0.0	0.1	0.0	0.0	0.0
Lower Los Pinos River	0.1	0.1	0.0	0.1	0.1
Lower Piedra River	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	0.0	0.3	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.1	0.0	0.0	0.0
Stollsteimer Creek	0.0	0.0	0.0	0.0	0.0

Table 3-26 Miles of Road on Slopes Greater Than 40 Percent

	Alternative (mi)				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	0.4	5.9	0.0	0.0	0.1
Lower Florida River	0.0	1.8	0.3	0.0	0.0
Lower Los Pinos River	1.7	6.2	0.3	0.4	1.3
Lower Piedra River	8.9	11.2	0.9	1.5	4.0
Middle Animas Valley	0.0	1.4	0.0	0.0	0.0
Middle Los Pinos River	0.6	1.6	0.5	0.6	0.6
Stollsteimer Creek	1.8	2.1	0.0	0.0	1.8
Total	13.4	30.2	2.0	2.5	7.8
National Forest					
Beaver Creek	0.0	2.5	0.0	0.0	0.0
Lower Florida River	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	0.0	3.8	0.0	0.0	0.5
Lower Piedra River	5.3	6.3	0.0	0.0	1.6
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	0.0	0.0	0.0	0.0	0.0
Total	5.3	12.6	0.0	0.0	2.1
BLM					
Beaver Creek	0.0	0.0	0.0	0.0	0.0
Lower Florida River	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	0.0	0.0	0.0	0.0	0.0
Lower Piedra River	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	0.0	0.0

Table 3-27 Miles of Road (Proposed) in WIZ for All Alternatives

	Alternative (mi)				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	0.9	3.6	0.8	0.8	0.9
Lower Florida River	0.6	1.3	0.3	0.3	0.6
Lower Los Pinos River	1.2	4.7	0.5	1.2	1.2
Lower Piedra River	7.2	7.5	3.4	4.0	5.2
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.8	1.3	0.8	0.8	0.8
Stollsteimer Creek	0.7	1.0	0.0	0.0	0.7
Total	11.4	19.4	5.8	7.1	9.4
National Forest					
Beaver Creek	0.1	2.1	0.0	0.1	0.1
Lower Florida River	0.0	0.0	0.0	0.0	0.0
Lower Los Pinos River	0.7	4.2	0.0	0.7	0.7
Lower Piedra River	7.2	7.5	3.4	4.0	5.0
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	0.9	0.9	0.0	0.0	0.7
Total	8.9	14.7	3.4	4.8	6.5
BLM					
Beaver Creek	0.3	0.3	0.3	0.3	0.3
Lower Florida River	0.3	0.3	0.0	0.0	0.3
Lower Los Pinos River	0.3	0.3	0.3	0.3	0.3
Lower Piedra River	0.0	0.0	0.0	0.0	0.0
Middle Animas Valley	0.0	0.0	0.0	0.0	0.0
Middle Los Pinos River	0.0	0.0	0.0	0.0	0.0
Stollsteimer Creek	0.0	0.0	0.0	0.0	0.0
Total	0.9	0.9	0.6	0.6	0.9

The total number of stream crossings was calculated as follows: The total number of new road construction miles for the Project Area by alternative is known. For existing roads and trails in the analysis area, there is an average of 1.73 stream crossings per linear mile. If this factor is applied to the number of miles of new road for each alternative, an estimate can be made of total number of new stream crossings. This estimate was used to present a comparison of relative risk to aquatic resources by alternative.

Table 3-28 Stream Crossings Estimate

	Alternative (number of stream crossings[1])				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	27	77	9	21	23
Lower Florida River	8	22	7	7	7
Lower Los Pinos River	10	19	9	10	10
Lower Piedra River	36	75	14	29	33
Middle Animas Valley	113	130	27	45	76
Middle Los Pinos River	8	12	0	0	8
Stollsteimer Creek	2	12	2	2	2
Total	204	347	68	85	159
National Forest					
Beaver Creek	19	57	1	11	15
Lower Florida River	0	0	0	0	0
Middle Los Pinos River	0	0	0	0	0
Lower Los Pinos River	21	56	0	14	22
Lower Piedra River	103	123	27	39	68
Stollsteimer Creek	8	10	0	0	8
Middle Animas Valley	0	0	0	0	8
Total	151	246	28	64	121
BLM					
Beaver Creek	1	1	1	1	1
Lower Florida River	2	8	1	1	2
Middle Los Pinos River	1	3	1	1	1
Lower Los Pinos River	6	6	2	6	6
Lower Piedra River	0	0	0	0	0
Stollsteimer Creek	0	0	0	0	0
Middle Animas Valley	0	4	0	0	0
Total	10	22	5	9	10

Note:
1. Stream Crossings are an estimate of new road intersections with intermittent drainages using a Water Quality Risk Index

The following discussion documents the potential impacts of the alternatives in the seven major analysis watersheds. The sedimentation impacts described below may affect fisheries. Appendix H presents the biological assessment of threatened and endangered species; Appendix I presents the biological evaluation of FS and BLM sensitive species, and Appendix J, presents the detailed analysis of management indicator species.

3.6.3.3 Beaver Creek Watershed

The Beaver Creek analysis area has been divided into sub-watersheds to organize the environmental consequences discussion. CBM wells were developed in a portion of the watershed in Sauls Creek in the early 1990s. Land ownership is a mixture of national forest and private land in-holdings and there are CBM wells developed and proposed on BLM, National Forest, and private lands (Table 3-29).

Table 3-29 Number of New Well Pads by Alternative and Jurisdiction

	Alternative (number of pads)				
Watershed	1	2	5	6	7
Project Area					
Beaver Creek	44	114	21	37	39
Lower Florida River	22	54	17	21	22
Middle Los Pinos River	25	47	23	24	25
Lower Los Pinos River	64	107	36	57	62
Lower Piedra River	95	129	16	33	67
Stollsteimer Creek	7	15	0	0	7
Middle Animas Valley	4	25	4	4	4
Total	261	491	117	176	226
National Forest					
Beaver Creek	25	70	1	18	20
Lower Florida River	0	0	0	0	0
Middle Los Pinos River	0	0	0	0	0
Lower Los Pinos River	27	67	1	20	25
Lower Piedra River	91	115	13	30	63
Stollsteimer Creek	7	12	0	0	7
Middle Animas Valley	0	0	0	0	0
Total	150	264	15	68	115
BLM					
Beaver Creek	0	0	0	0	0
Lower Florida River	2	5	0	1	2
Middle Los Pinos River	1	1	0	1	1
Lower Los Pinos River	9	8	0	9	9
Lower Piedra River	0	0	0	0	0
Stollsteimer Creek	0	0	0	0	0
Middle Animas Valley	0	8	0	0	0
Total	12	22	0	11	12

Road density under Alternative 1 determined from road network analyzed in roads analysis (FS 2003b). Road density under Alternatives 2-5 determined using centroid methodology (If center of well pad falls within WIZ, then it was assumed that the length of the access road also fell within the WIZ.)

NOTE: Stream Crossings are an estimate of new road intersections with intermittent drainages using a Water Quality Risk Index

3.6.3.3.1 Northern and Middle Section of Beaver Creek and Sauls Creek

The northern and middle sections of Beaver Creek are heavily developed. There are highways built along to most of the stream length, as well as access roads, well pads, agricultural clearing, and grazing. Beaver and Sauls Creek both have perennial flow supporting riparian vegetation. Steep, dissected hill slopes and erosive soils are present along sections of Beaver and Sauls Creek. This area has experienced erosion in the past, as evidenced by a series of erosion control dams and ponds built in past decades on the National Forest. There is a moderate level of agricultural activity near the Beaver Creek and Sauls Creek confluence. Sauls Creek watershed has had previous CBM development and has a number of well

pads and roads. There is a major access road adjacent to Sauls Creek that frequently enters the WIZ over a stretch of 3 to 4 miles.

Beaver Creek

The alternatives would all result in increased surface disturbance, ranging from 59 acres for Alternative 5 to 387 acres for Alternative 2 (Table 3-18). Approximately 65 percent of this new surface disturbance would occur on National Forest, two percent on BLM and 33 percent on private land (Table 3-18). Increased erosion and sediment delivery to streams would be expected because between 9 and 18 percent of new disturbance would occur in the WIZ where erosion has the greatest potential to enter streams (Table 3-20). The existing road network in this densely developed area would provide access to the majority of the proposed wells; however, new road construction would be required in the northern portion of Beaver Creek (Table 3-24). One compressor station would be located, on private land within the WIZ of main-stem Beaver Creek under all alternatives. During field siting the FS would investigate moving the compressor station to the west side of Highway 160 away from erosive soils and the Beaver Creek floodplain.

Alternative 2 would involve a large amount of road and well construction within the WIZ in the northern section of the Beaver Creek watershed. This alternative would result in 387 acres of short-term disturbance and 259 acres of long-term disturbance within the watershed, which is the highest of any alternative in any Project Area watershed (Table 3-18 and Table 3-21). National Forest and BLM development would contribute to approximately 70 percent of the disturbance totals as described on Table 3-18 and Table 3-21. There would be high risk for sediment delivery to impact Beaver Creek and tributaries, floodplains, and overall watershed condition. Continued degradation of the existing condition of Beaver Creek would be expected, and the negative stream impacts would be greatest as a result of Alternative 2.

Sauls Creek

Minimal development would occur along the lower and middle reaches of Sauls Creek watershed under all alternatives. Therefore, there is low risk for sediment delivery from development to impact the middle and lower reaches of Sauls Creek. However, a compressor station located on or above a pre-existing landslide could present a risk of triggering further mass failure and delivering sediment the lower reaches of Sauls Creek. The FS would investigate moving the compressor station during field siting, or geotechnically engineering the site to reduce the potential for mass failure at the general location.

A moderate amount of development would occur in the upper reaches of Sauls Creek on mixed jurisdictions under Alternatives 1, 6, and 7. An increase in erosion and sediment delivery to the upper reaches of Sauls Creek would likely result from these three alternatives.

Alternative 2 would involve constructing many more wells, than the other alternatives, within the WIZ in the headwaters of Sauls Creek in an area where there are steep slopes, dissected hillslopes, and highly erosive soils. If wells cannot be sited outside the WIZ during field review, then well and road construction would

increase erosion and sediment delivery, and floodplain modifications would highly impact and further degrade existing conditions in Sauls Creek.

Under Alternative 5, one well accessed by an existing road, would be constructed throughout the entire Sauls Creek sub-watershed. Therefore, there is low risk for sediment delivery to impact Sauls Creek.

3.6.3.3.2 Lange Canyon

Lange Canyon is an intermittent stream that supports riparian vegetation. The upper watershed is undeveloped. The lower watershed, which is mostly National Forest, contains one road. There are steep slopes and erosive soils in both the upper and lower reaches of Lange Canyon.

Alternative 1 would require pipeline construction on National Forest in a tributary to Lange Canyon within the WIZ and on steep (>40 percent), erosive slopes, old landslide deposits, and landslide hazard areas, creating a high likelihood for mass slope failure and large quantities of sediment to enter Lange Canyon Creek. The risk of environmental impacts, even with geotechnically-engineered facilities, would be high as a result of the proposed pipeline location.

Alternatives 1, 2, and 7 would require several miles of side-hill road construction across very steep sections of erosive soils, and landslide hazard areas on National Forest in the headwaters of Lange Canyon. Because the road would cross Lange Canyon twice, it is likely that road derived erosion would be delivered to Lange Canyon Creek. Alternative 6 involves constructing only the first half of this proposed access road and avoids the steepest, high hazard areas associated with Alternatives 1, 2, and 7. Therefore, the impacts of Alternative 6 would be lower than Alternatives 1, 2, and 7.

Alternative 1 and 2 would involve constructing road on National Forest along the drainage divide between Lange Canyon headwaters and Lower Piedra watershed. Steep slopes, erosive soils, and landslide hazard areas are common to this proposed road location. Even with geotechnical engineering of the road, the risk is high for sediment delivery and massive slope failures to impact this section of Lange Canyon.

No new development would occur in Lange Canyon under Alternative 5. Therefore, there would be no impacts in Lange Canyon from this alternative.

3.6.3.3.3 Lower Beaver Creek Watershed: Crowbar Creek and Armstrong Canyon

Existing development in Crowbar Creek and Armstrong Canyon consists of a low level of agricultural activity in the lower reaches of both drainages. Armstrong Canyon is an intermittent stream that supports riparian vegetation, while Crowbar Creek is ephemeral. Both drainages are incised into highly erosive soils. There are steep and dissected hillsides along sections of the channel in Crowbar Canyon. There are also steep slopes (>40 percent) and erosive soils along the drainage divide of Armstrong Canyon. The valley floor is wide and vegetative cover is sparse in the lower reaches of Crowbar and Armstrong Canyons. The assessment of exact road and well pad impacts is difficult in this area because

only drilling windows are projected and actual road locations have not been determined. CBM development in this sub-watershed would occur mostly on private land.

Under Alternatives 1, 5, 6, and 7, there are a number of well windows where well pad development would occur within the Crowbar Creek WIZ, and there is one window in the Armstrong Canyon WIZ. It is possible road locations would cross the creeks and enter the WIZ. As a result, construction activities would have considerable watershed impacts to Crowbar Canyon. Some of the well windows in this drainage are split between private land and National Forest. If APDs are filed on National Forest, well pad relocations would be analyzed to try and avoid WIZ impacts if possible. Very limited activity is proposed within Long Canyon and the Trail Creek tributaries for these four alternatives, and impacts are expected to be low in these watersheds.

Alternative 2 would result in high road and well pad densities on both National Forest and private land within the WIZ of both Crowbar and Armstrong Creeks. Some well pads and roads would be constructed on old landslide deposits unless exceptions to spacing locations are implemented. Considerable watershed impacts to both Crowbar Creek and Armstrong Canyon would be expected due to the magnitude of development. Floodplain modifications and water quality impacts would likely occur. It would not be possible to effectively site at least two proposed wells out of highly erosive, steep, landslide prone areas; therefore increased erosion would be expected.

Alternatives 1 and 2 would require constructing a road, well pads, and compressor station along the drainage divide on National Forest between Armstrong Canyon and the Piedra River watershed. Sections of the road would traverse steep slopes and erosive soils, creating a high likelihood for mass slope failure and sediment delivery to watershed streams. Even with geotechnical road design, the probability of slope failure with a road in this location would be high. Alternatives 6 and 7 would require road construction/reconstruction only in the southern part of the same watershed divide. Although fewer roads are required, there would be the same risks of building on landslide hazard zones, and erosive soils, although to a somewhat lesser extent.

3.6.3.3.4 Summary

Beaver Creek watershed is an area where National Forest, BLM, and private lands are intermingled, each contributing to watershed effects as a result of CBM development (Figure 2–2 and Figure 3–26). Approximately 65 percent of this new surface disturbance would occur on National Forest, two percent on BLM and 33 percent on private land (Table 3-18). Existing high development impacts within the Beaver Creek watershed, combined with the proposed CBM development common to all alternatives would increase sediment yield and subsequent channel adjustments. Continued degradation of the existing condition of Beaver Creek would be expected.

All alternatives involve a high amount of new CBM development in the Beaver Creek Watershed. This activity would result in surface disturbance and increased erosion in the WIZ throughout the Beaver Creek watershed. Existing estimated soil loss from CBM development in the Beaver Creek watershed is 3,000 tons/

year, which is among the highest of the seven analysis watersheds. Soil losses for Alternative 2 would increase short-term and long-term to an estimated maximum total of 6,700 tons/year and 5,500 tons/year, respectively (Tables 3–41 and 3–44). Alternative 5 would result in the smallest increase in short- and long-term annual soil loss, resulting in 3,500 tons/year and 3,300 tons/year, respectively (Tables 3–41 and 3–45). Surface impacts would be greatest along Beaver Creek, reaches of Sauls Creek, Crowbar Creek, and Armstrong and Lange Canyon.

New road construction on all jurisdictions throughout the Beaver Creek watershed would range from a high of 44.4 miles for Alternative 2, to a low of 5.4 miles for Alternative 5 (Table 3-24). Alternative 2 road construction would total 3.6 miles within the WIZ (Table 3-27) and 5.9 miles constructed on slopes greater than 40 percent (Table 3-26). Approximately 50 percent of the new CBM road construction would occur on National Forest and the remainder on private land. Alternative 2 would result in the largest overall impact to watershed health and water quality. Mass failures could result for road construction and reach streams in Lange and Armstrong Canyons and Sauls Creek sub-watersheds. Sediment delivery due to these slope failures could present considerable impact to these sub-watersheds. Alternative 7 poses a somewhat reduced threat to water quality; however, road construction associated with Alternative 7 in Lange Canyon would present a high risk of negative watershed health and water quality impacts. Alternative 7 requires a ridge road between the divide of Armstrong Canyon and Ignacio Creek watershed, which carries a moderate risk of watershed impacts due to landslide potential, erosive soils, and the steep dissected landscape. Alternatives 5 and 6 would have the lowest overall watershed impacts relative to the other alternatives (Table 3-18 to Table 3-27).

3.6.3.4 Middle Los Pinos River Watershed

Mineral estate in the middle Los Pinos watershed is comprised of BLM, State and private lands. The BLM mineral estate is overlain by private land, creating a split estate situation. Most of the 320-acre spacing units have been developed on all jurisdictions and a moderate level of development at 160-acre spacing has also occurred. Existing CBM land disturbance by jurisdiction is displayed on Table 3-14. The entire main stem Los Pinos River in this 4th level watershed is highly developed by roads, agriculture, gravel mining, grazing, scattered homes, and well pads. Large impacts from gravel mining, roads, and agriculture occur in the WIZ along the lower portion of the Los Pinos. There is heavy agricultural development in the floodplain along the entire main stem. The main stem of Los Pinos is a perennial stream with developed floodplains and established mature riparian vegetation. Additional CBM development would occur on private, State and BLM land within this watershed

3.6.3.4.1 Main Stem of Middle Los Pinos River

The main stem Los Pinos River contains private mineral estate. Federal mineral estate CBM development would not contribute to watershed impacts in the main stem of the middle Los Pinos River. All alternatives would result in surface disturbance and increased erosion on private land in the WIZ throughout the main stem of Los Pinos River. There is a high percentage of development within the WIZ in the lower reaches of the Los Pinos River. Additionally, the location of three well windows in the WIZ and three well windows in the floodplain along

the middle and lower reaches suggest that future road and well pad construction would occur on private land within the WIZ and floodplain, unless exception well locations prove feasible during well siting. Well siting outside of the WIZ and floodplain could avoid these impacts. Additional development within the WIZ would considerably impact this section of the watershed.

Alternative 2 would result in an additional 13 acres of short-term potential disturbance and 10 acres of long-term potential disturbance within the WIZ when compared with the other alternatives.

Alternative 5 is nearly identical to Alternative 1, though it has two fewer well sites on BLM mineral estate, which accounts for 3.5 fewer acres of disturbance.

For all alternatives, riparian vegetation and floodplains would be highly impacted in the lower and middle reaches of the Los Pinos River and moderately impacted in the upper reach due to road and well construction locations. Additionally, sediment yield increases and channel changes would occur along the entire main stem Los Pinos River due to the existing watershed impacts and the location of well windows in proximity to streams. Wells should be sited outside of the WIZ to most effectively mitigate these impacts.

3.6.3.4.2 Wallace Gulch and Northern Tributaries

Wallace Gulch is an intermittent stream that supports riparian vegetation. Most of the drainage is private land with some small BLM parcels intermingled. There are steep, dissected hill slopes and erosive soils along sections of Wallace Gulch. Wallace Gulch is moderately developed by well pads, roads, and agricultural use. There is heavy agricultural use and a few well pads in, or within proximity to, the WIZ and along the floodplain. There is also a high level of disturbance along and around the ephemeral northern tributaries draining into Wallace Gulch. The areas of high disturbance include well pads, a large subdivision, and county roads.

Surface disturbance and increased erosion in the WIZ in the upper and lower most reaches of Wallace Gulch would occur under all alternatives. Although the majority of proposed wells are located to the north of Wallace Gulch, the construction of three well pads in the WIZ along the upper and lower reaches of Wallace Gulch under all alternatives would increase the level of impact to this watershed.

Alternative 2 would result in a considerable increase in road and well pad construction to the north of Wallace Gulch. Agricultural use and well pads heavily impact riparian vegetation and floodplains along the upper and lower reaches. Additional construction would increase the level of impact. Sediment yield increases and potential channel changes would occur in the upper and lower reaches of Wallace Gulch.

3.6.3.4.3 Bear Creek

Bear Creek is a perennial stream. The section of the Creek within the project area supports riparian vegetation that includes willows and cottonwood trees. There are steep, dissected hill slopes and erosive soils on both sides of the Creek. Minimal development (agricultural use and roads) exists in this section of the

Creek. The alternatives would not result in additional disturbance within the Bear Creek watershed.

3.6.3.4.4 Summary

Additional CBM development within the WIZ would occur on private lands. Increased impacts to the WIZ would occur in the middle and lower reaches of Los Pinos River and the upper and lower reaches of Wallace Gulch due to CBM development on other jurisdictions. Soil erosion within the WIZ would be expected to reach surface drainages, even with the implementation of mitigation measures. The greatest potential for soil loss would occur along the lower reach of the Los Pinos River drainage and along Wallace Gulch. Considerable impacts would occur in riparian areas in the middle and lower reaches of Los Pinos, and increased impacts would occur in floodplains along the upper reach of the Los Pinos and upper and lower reaches of Wallace Gulch. Existing estimated soil loss due to CBM development in the Middle Los Pinos watershed is 1,220 tons/year (Table 3–41). Soil losses for Alternative 2 would increase short-term and long-term to an estimated maximum total of 1,850 tons/year and 1,650 tons/year, respectively (Table 3-44). Alternative 5 would have the smallest increase in short- and long-term annual soil loss, resulting in 1,540 tons/year and 1,440 tons/year, respectively (Table 3-45).

Road construction throughout the watershed ranges from 11 miles for Alternative 2, to approximately 5 miles for all other alternatives (Table 3-24). Alternative 2 has the highest level of proposed new road and well construction, which includes 1.3 miles within the WIZ and 1.6 miles constructed on slopes greater than 40 percent (Table 3-26 and Table 3-27). Alternative 2 would result in the greatest overall impact to watershed health and water quality followed by Alternatives 1, 7, 6, and 5, which would have smaller effects.

3.6.3.5 Stollsteimer Creek Watershed

Proposed CBM development within Stollsteimer Creek watershed would occur entirely on National Forest. Stollsteimer Creek has perennial flow supporting riparian vegetation. There are steep, dissected hill slopes, areas of sparse vegetative cover and erosive soils along both sides of this creek. Stollsteimer Creek is listed on the State of Colorado Monitoring and Evaluation List for water quality impairment from sediment (CDPHE 2006). A minimal level of development consisting of roads and agricultural activity exists within the analysis area.

3.6.3.5.1 Stollsteimer Creek

Alternatives 1 and 7 would have very limited construction and impact in the WIZ of Stollsteimer Creek, involving construction of one well potentially within the WIZ.

Alternative 2 involves development of one well potentially within the WIZ of Stollsteimer Creek, and a few other wells just beyond the WIZ. An increase in surface disturbance and increased erosion in these areas would have minor effects on riparian areas and floodplains.

Alternatives 5 and 6 have no development within the WIZ of Stollsteimer Creek.

3.6.3.5.2 Unnamed Side Tributaries to Stollsteimer Creek

Steep, dissected hill slopes and erosive soils exist along unnamed side tributaries of Stollsteimer Creek near the southern boundary of the Project Area. There is no current development in these areas.

Alternatives 1, 7, and 2 would potentially result in construction of one well and one compressor station within the WIZ of the larger tributary. An alternate location for the compressor on moderate side slopes outside the WIZ would be investigated during field siting. In addition, sections of a proposed well access road would be located in the WIZ of both tributaries and traverse steep slopes and erosive soils. Alternatives 1 and 7 have 4 wells. Alternative 2 has 6 wells and would produce substantially more erosion.

Alternatives 5 and 6 would not impact the tributaries of Stollsteimer Creek.

Under all alternatives, roads and well pads would be sited to avoid WIZ impacts to the extent practical.

3.6.3.5.3 Deep Canyon

Deep Canyon is largely undeveloped with the exception of one FS low standard road located in a narrow valley bottom. Deep Canyon is an ephemeral channel with steep, dissected hill slopes and erosive soils on both sides of this channel. This canyon, and surrounding watershed, has a high potential for wind and water erosion.

Alternatives 1 and 7 would increase surface disturbance and erosion due to construction of one well and access roads on steep slopes and erosive soils, and two additional wells on ridge tops. Alternative 2 increases surface disturbance and erosion more so than Alternative 1 because it has an additional well in the WIZ, a portion of the pipeline in the WIZ, and 2 additional wells and associated access roads and the remainder of the pipeline on highly erosive, dissected, steep slopes.

Alternatives 5 and 6 would have no impact to Deep Canyon.

3.6.3.5.4 Summary

The direct impacts of all action alternatives on Stollsteimer Creek would be moderate. However, due to the concentration and location of development in Alternatives 1 and 2 in the unnamed tributary and Deep Canyon, the risk of sediment yield and subsequent channel changes would increase in Stollsteimer Creek. Impacts would be greatest in the unnamed tributary and Deep Canyon sub-watersheds. Under Alternatives 1 and 2, pipelines and roads would be located on highly erosive, dissected, steep slopes in Deep Canyon. Sediment yield and channel changes would increase due to the sensitive locations of the pipeline, roads and well pads. Existing estimated soil loss from CBM development in the Stollsteimer watershed is 90 tons/year (Table 3-41). Soil losses for Alternative 2 would increase short-term and long-term to an estimated maximum total of 880 tons/year and 600 tons/year, respectively (Table 3-44). Alternatives 5 and 6 would result in no increase in annual soil loss (Table 3-45 and Table 3-46).

Road construction in the WIZ throughout this watershed is low, ranging from a total of one mile for Alternative 2 to no miles for Alternative 5. Eroded soils within the WIZ would be expected to reach surface drainages. New construction on steep, erodible soil ranges from 2.2 miles for Alternative 2 to 0 miles for Alternative 5.

If Stollsteimer Creek is found to be impaired by sediment (CDPHE 2006), additional mitigation beyond that specified in this EIS may be required. Off-site mitigation to reduce sediment from sources outside the project boundary may be necessary to compensate for disturbances from the proposal.

3.6.3.6 Lower Los Pinos Watershed

The Lower Los Pinos watershed is bisected by the analysis area into a western and eastern portion. Proposed CBM development, existing watershed condition, and associated development effects differ in the west Lower Los Pinos watershed compared to the eastern portion of the watershed. Streams in the west include Dry Creek, Homer Canyon, Holman Canyon, and Hartman Canyon. All the sub-watersheds in the west Los Pinos have existing CBM development and are primarily on private lands, BLM mineral estate (including split estate lands), and a minor amount of State land (Figure 2–2 and Figure 3–26). Dry Creek and Homer Canyon have intermittent streams that support riparian vegetation. Spring Creek and Ute Creek, both intermittent streams that support scattered riparian vegetation, are in the eastern portion of the watershed. Development in the eastern sub-watersheds ranges from low levels of existing development to no development. The eastern sub-watershed is primarily National Forest with a smaller amount of private land. CBM development in the Lower Los Pinos watershed has occurred on all four jurisdictions and would continue to occur on BLM, National Forest and private jurisdictions. Approximately 50 percent of the watershed impacts realized from CBM development would be as a result of development on national forest and 20 percent would be as a result of development of BLM lands, the remainder of impacts would be as a result of CBM development on private and State lands (Table 3-18).

3.6.3.6.1 West Los Pinos Watershed

Within the western part of the watershed, similar CBM development impacts are expected for all alternatives due to development on private, State, and BLM lands (Table 3-29). High levels of road and well pad development would occur in the Dry Creek sub-watershed. Road and well pad construction within the WIZ would likely modify floodplains, impact riparian vegetation, and increase erosion and sediment delivery to Dry Creek. All development in the WIZ would occur on private land in Dry Creek. Impacts in Holman Canyon and Hartman Canyon would result from construction on erosive soils and within the WIZ. The three wells proposed in Hartman Canyon are in mapped landslide hazard areas. Consequently, there is increased risk of landslide debris that could impact a tributary Hartman Canyon, and sediment-laden waters from landslides could reach Hartman Canyon. All alternatives would likely result in increased erosion and increased sediment delivery to these streams. Impacts to floodplains would likely occur.

Moderate development is proposed within Homer Canyon. There is one well window on highly erosive soils, which would cause localized erosion, and one well proposed in a landslide hazard area. Landslide-derived sediment could impact the drainage in all alternatives.

3.6.3.6.2 East Los Pinos Watershed

Both private lands and National Forest would be developed in the east Los Pinos Watershed (Table 3-29). Alternative 1 would result in potentially high watershed impacts. The majority of new road construction would be concentrated in the Spring Creek area of the east Los Pinos watershed on National Forest. There would be minor development within the tributaries of Ute Creek, Ritter, Reservoir, and Green Canyons.

It is anticipated that Zabel Canyon and vicinity could have moderate to high watershed impacts on National Forest. This is an area that has had erosion problems in the past, as evidenced by construction of erosion control structures in past decades. There are over three miles of road and nine wells proposed for Zabel Canyon in Alternative 1. Two wells and several portions of road are proposed in landslide hazard areas. In two places, the roads are on steep slopes within the WIZ and proceed directly to a stream crossing, increasing the probability that sediment is routed directly to the stream. On-the ground investigation (including analysis of directional drilling) would be conducted before road and well location proceed in this location. Two tributaries south of Spring Creek on National Forest near the southern edge of the Project Area have less landslide potential, but could still sustain some watershed impact because of wells and roads in the WIZ and on erosive soils.

The portion of the watershed with the most significant watershed impacts is upper Spring Creek and Salt Creek, both of which are on National Forest. Several miles of road would be constructed on the ridge between these two streams and Ignacio Creek, which would traverse extremely steep, narrow ridgelines with high landslide and erosion potential. Six of the nine well pad locations on the Spring Creek side are in landslide areas with very steep, unstable, and erosive ridgelines and hillsides. Some locations may require cut and fill construction. Impacts within the upper watershed are anticipated to be high in some locations. There is also high risk for pipeline rupture or catastrophic failure after construction through high landslide hazard areas. If a produced water pipeline were to break in this area, it could take hours to reach and begin repair of the break due to the remote location of this ridgeline. If large volumes of contaminated produced water spills over this steep, dissected, and unstable landscape, high volumes of sediment could be delivered into Project Area streams from resulting erosion. In summary, for Alternative 1, there is high risk for erosion to impact the stream, floodplains, and overall watershed condition.

Alternative 2 impacts would be greater than those projected for Alternative 1. In addition to the impacts described above, Alternative 2 would involve extensively developing the un-roaded tributaries to Ute Creek; Ritter, Reservoir, and Green Canyons on National Forest (Figure 2–3). New construction in these canyons greatly increases total road density, the number of stream crossings, road construction on highly erosive soils, and construction of facilities in the WIZ. There would be direct impacts on stream channels, and floodplain modification would

occur. Increased sedimentation to Ute Creek and its three tributaries would likely result in considerable negative impacts to channel stability and channel function. Implementation of watershed best management practices, engineered road design and well siting would partially mitigate this impact, but watershed impacts would still be considered high.

Alternative 5 would result in less watershed impact than Alternatives 1 and 2. This alternative does not involve development of the steep, unstable lands. Mass failure risk would be largely avoided. Most of the new roads in this area would avoid erosive soils, and would be located away from streams. For these reasons, mitigation measures should be effective at reducing sediment production and delivery to streams.

Alternative 6 would have the same impacts in Zabel Canyon and the southern tributaries as Alternatives 1 and 2. Watershed impacts in upper Spring Creek and Salt Creek for Alternative 6 are greatly reduced compared to Alternative 1. There is no new road construction in these upper watershed reaches. The only impacts resulting from Alternative 6 would be construction of well pads, two in valley bottom locations that might have slight impacts to floodplains, and construction of one well pad mid-slope.

Alternative 7 would have the same impacts in Zabel Canyon and the southern tributaries as Alternatives 1, 2, and 6. Watershed impacts in upper Spring and Salt Creek would fall between those of Alternative 1 and those of Alternative 6 in terms of severity. The ridge top road is less than half as long as proposed in Alternative 1, and avoids the worst steep slopes. Six wells are proposed in upper Spring and Salt Creek area, and three of them are in landslide hazard and steep slope areas. Pipeline and road construction is still proposed across landslide hazard areas for Alternative 7. The risk of pipeline rupture is high in these areas, and could result in severe erosion if large volumes of produced water flow toward streams. Alternative 7 decreases watershed impacts substantially in upper Spring and Salt Creek when compared to Alternative 1, but landslides and construction-derived sediment could still have detrimental impacts to several tributaries of Salt and Spring Creek.

3.6.3.6.3 Summary

Overall total road densities in the watershed (existing and proposed) would range from 1.8 mi/mi^2 in Alternative 5 to 2.6 mi/mi^2 in Alternative 2 (Table 3-15 and Table 3-25). A total of eight miles of new road would be built for Alternative 5 and 42 miles of new road for Alternative 2 (Table 3-24).

Differences among alternatives are most pronounced in the eastern portion of the watershed. Alternative 2 would result in the greatest overall impact on watersheds, stream conditions, and water quality. A total of 4.7 miles of road would be constructed in the WIZ (and potentially floodplains and riparian areas), and a number of well pads would be potentially located in floodplains (Table 3-27). Although not quantified, mass failure risk is expected to be highest under Alternative 2.

Zabel Canyon and southern tributaries have the same high to moderate impacts under all alternatives. Upper Spring and Salt Creek have high risk of landslides,

with roads and wells along approximately 5 miles of ridgelines in Alternative 1. This landslide risk is decreased but not eliminated in Alternative 7, which has road and well development along approximately 2.5 miles of high-risk ridges.

Alternative 2 surface erosion would be highest, with 4,900 tons/year of new sediment generated in the short-term, resulting in a total of 8,770 tons of sediment per year (Tables 3–41 and 3–44). Sediment quantities generated from potential mass failures are not included in the surface erosion estimates.

3.6.3.7 Middle Animas Valley Watershed

Land and mineral estate jurisdictions in this watershed are split between BLM, State, and private lands in almost equal proportions (Figure 2–2 and Figure 3–26). With the exception of Alternative 2, there would be no new CBM development on BLM lands The analysis area covers a relatively small portion of a large watershed (Figure 3–26). It includes a portion of the Animas River and two intermittent tributaries, Wilson Gulch and Big Canyon. The relatively undeveloped Big Canyon is primarily BLM land and supports riparian vegetation. Wilson Gulch is moderately to highly developed, containing agricultural fields, roads, CBM wells, homes, and businesses.

The proposed activities in the Middle Animas Valley are the same for Alternatives 1, 5, 6, and 7. The level of new CBM development is low; six new wells would be constructed. Access to the well sites would require no new road construction in the WIZ and no new roads on steep slopes. Most of the development would occur on gentle or flat terrain. Two of the proposed general well locations and one compressor station include areas with high landslide potential. However, field siting of the well pads and compressor station locations would attempt to locate the wells and compressor station outside of these landslide potential areas. Watershed impacts would be low as a result of Alternatives 1, 5, 6, and 7.

CBM well development would be more extensive under Alternative 2 compared with the other alternatives. Up to 25 new wells would be constructed in the watershed in Alternative 2, with 8 wells on BLM land (Table 3-29). No new road construction would occur in the WIZ. However, 1.4 miles of new road would traverse very steep slopes and cross canyon-like topography (Table 3-26). Wells would be developed in the steep upper drainages of Big Canyon. Construction in the WIZ and cut and fill construction in the steep, dissected terrain of this area would likely cause erosion that would directly impact Big Canyon and transport to the Animas River.

3.6.3.8 Lower Florida River Watershed

Mineral estate in the lower Florida River watershed is split fairly evenly between BLM and private mineral estate and is substantially developed. There is, in addition, a smaller amount of CBM development on State lands (Figure 2–2). Further development on each jurisdiction is described on Table 3-29. Approximately 10 percent of new watershed disturbance would be a result of CBM development on BLM lands, while the remainder, 90 percent, would be as a result of private mineral estate development. With the exception of the Florida River, streams in this watershed are intermittent. The Florida River is currently in poor condition but shows an upward trend within the analysis area. Recent large-scale sedimen-

tation and flooding after the Missionary Ridge Fire has degraded Florida River water quality and channel conditions (FS 2002b). Severe water shortages due to drought and diversions have also negatively impacted the aquatic habitat. Recent impacts from fire, flooding, and drought have severely impacted or eliminated Florida River fish populations in some reaches within the Project Area. Less development has occurred in the N/NW portion of the Project Area watershed due to steep, dissected slopes and erosive soils. The southern part of the watershed has gentle topography and has varied development, including homes, agriculture, roads, and CBM wells.

Road construction in the WIZ would be moderately low in this watershed, ranging from 0.3 miles for Alternatives 5 to 1.3 miles for Alternative 2 (Table 3-27). New construction on erosive soils would occur. Erosion and soil loss within the WIZ would be expected to reach surface drainages, even with mitigation measures. Many well windows are located within the WIZ. Wells would be sited outside of this zone where feasible based on field siting. The total number of new road miles across the entire watershed ranges from 4.2 miles in Alternatives 5 and 6 to 12.8 miles for Alternative 2 (Table 3-24).

Alternative 2 would result in a high level of development in the north/northwest part of the watershed, primarily on BLM lands where the land is steeper, dissected by many streams, erosive, and relatively undeveloped. Many of the proposed additional wells are in areas of high landslide hazard. The other alternatives largely avoid these areas. The 1.3 miles of road constructed in the WIZ in Alternative 2 is greater than required for the other alternatives, as is the 12.8 miles of new access road that would be required (Table 3-24 and Table 3-27).

3.6.3.8.1 Summary

The Florida River is in poor, but improving, condition due to uncharacteristically high sediment loads produced from the Missionary Ridge fire and subsequent flooding upstream of the Project Area. New construction, especially roads located in floodplains, have a moderate to high risk of producing increased sediment directly to intermittent streams and, potentially, to the Florida River. Existing CBM development soil losses are estimated to be 970 tons/year (Table 3-41). The alternatives would increase soil losses by a range of 120 tons/year (1,090 tons/year total) short-term for Alternative 5 to 370 tons/year (1,340 tons/year total) short-term for Alternative 2 (Table 3-41 and Table 3-43 through Table 3-47). The alternatives would increase soil losses by a range of 80 tons/year (1,050 tons/year total) long term for Alternative 5 to 250 tons/year (1,220 tons/year total) long term for Alternative 2.

Alternative 2 would result in the highest overall negative impact to watershed health and water quality, and would have the greatest likelihood that construction-related erosion would route through intermittent streams into the Florida River. This determination was based on both the location of new construction and the overall larger volume of erosion-related sediment associated with Alternative 2. Increased sediment delivery associated with all alternatives would likely prolong recovery time of aquatic habitat, water quality, and channel equilibrium in the Florida River.

3.6.3.9 Lower Piedra River Watershed

The lower Piedra River watershed is dominated by National Forest land and has one State section subject to CBM development (Table 3-18 and Table 3-24). There are also 14 proposed wells that are split estate lands comprised of private mineral estate and National Forest surface.

3.6.3.9.1 Little Squaw, Goose, Ignacio, and Bull Creeks

The upper watershed of Little Squaw Creek is undeveloped and has a narrow valley bottom with steep, erosive, and unstable hillsides and landslide deposits. The lower watershed has one existing road along the open, gentle valley bottom with well-developed riparian areas. Goose and Bull Creeks are undeveloped canyons with perennial flow and riparian vegetation. Ignacio Creek is an intermittent stream, undeveloped in the upper watershed. The lower watershed is developed with roads and four CBM wells.

Alternatives 1 and 2 would modify a high percentage of the WIZ, riparian areas, and floodplains due to new road construction in these four watersheds. Road construction in narrow canyon corridors may require fill material to be built into floodplains or channels. New road construction would also traverse areas of steep, dissected slopes with erosive soils. Additionally, high overall road densities would result from these alternatives. Because of the proposed construction locations, sediment yield increases, floodplain modification, water quality impacts, and negative stream channel changes are likely.

Ignacio Creek

Impacts to the Ignacio Creek watershed are expected to be high for Alternatives 1 and 2. A large number of new road/stream crossings, high road density, and some construction in the WIZ are projected within the lower Ignacio Creek watershed. Proposed roads would cross several dissected slopes with erosive, bare soils. Sediment delivery to channels would increase significantly. The upper watershed would have several miles of road and pipeline constructed on extremely steep, narrow ridgelines with areas of high landslide and erosion potential in many places. Well pad locations would require cut and fill on very steep, often unstable and erosive ridgelines, and side slopes. A pipeline in the Sheep Canyon tributary would be located in a steep, narrow valley bottom with erosive, unstable soils in the WIZ. The risk is also high of pipeline rupture or catastrophic failure after construction through high landslide hazard areas. If a produced water pipeline were to break in this area, it could take hours to reach and begin repair of the break due to the remote location of this ridgeline. If large volumes of contaminated produced water spill over this steep, dissected, and unstable landscape, high volumes of sediment could be delivered into Project Area streams from resulting erosion.

Impacts in the upper watershed are anticipated to be extremely high in some locations. There would be high risk for sediment delivery, slope failures, and mass wasting impacts to the stream and watershed under Alternatives 1 and 2. Ignacio Creek is an intermittent stream that flows directly into the Piedra River. Construction-derived sediment delivered to Ignacio Creek would likely also transport to the Piedra River, a perennial fish-bearing stream.

Most potential watershed impacts associated with Alternatives 1 and 2 are avoided entirely with Alternatives 5 and 6. There would be little or no new construction planned for these alternatives in the Ignacio Creek watershed.

One area of new construction included in Alternative 7 would be new road construction/reconstruction on a ridge between the divide of Armstrong Canyon and Ignacio Creek proposed for Alternative 7. Directional drilling well pads along this road would need more excavation and cut/fill construction than typical pads due to steep and unstable terrain. Construction of this road and associated pipelines poses a moderate to high risk of watershed impacts due to building across landslide hazard areas, erosive soils, and the steep, dissected landscape. The risks associated with constructing pipelines over high landslide hazard areas still exist with Alternative 7.

Little Squaw Creek

Alternatives 1, 2, and 7 have similar proposals for well and road construction, and would have similar effects. A number of conceptual well pad locations and proposed road are within the WIZ. The road location proposed for these alternatives would require many new stream crossings in dissected topography, which would increase direct and indirect stream impacts within a relatively undisturbed watershed. The road- and well-related impacts would be greatest in Alternative 2, which has the greatest overall amount of proposed construction disturbance. Many of these well locations and the road could be relocated away from the stream channel, which would greatly reduce impacts from construction-derived sedimentation.

Alternative 2 would also require pipeline construction in the canyon headwater areas of Little Squaw Creek. Field examination confirms that pipeline construction would impact steep slopes with highly erosive soils and landslide hazard areas. The risk of pipeline failure and subsequent surface water pollution and severe erosion is very high with this pipeline location. Road, well, and pipeline construction in Alternative 2 would result in greatly increased sedimentation within this relatively undisturbed watershed. Even with geotechnical engineering, there is a high likelihood of significant negative impacts to the watershed and to Little Squaw Creek.

Alternatives 5 and 6 would have fewer negative effects in Little Squaw Creek compared with Alternatives 1, 2, and 7. There would be significantly less new road constructed in high risk areas compared to Alternatives 1, 2, and 7. There would be approximately 1 mile of new road constructed adjacent to Little Squaw Creek and within the WIZ. Field examination confirms that erosive soils exist in the WIZ and new proposed road locations. For mitigation purposes, well locations could be relocated to avoid the necessity of new road stream crossings, and the road could be relocated away from the stream channel, which would greatly reduce impacts from construction-derived sedimentation. The opportunity to make these siting adjustments would be addressed during field siting of facilities.

Goose Creek

Alternatives 1, 2, 6, and 7 propose similar activities, and would result in the greatest impacts to Goose Creek. Alternative 5 would have similar but slightly

lower watershed impacts due to less overall new construction. Every alternative proposes new road construction adjacent to the entire length of Goose Creek. This includes many new road stream crossings and much construction within the WIZ. Field examination confirms many, if not all of these crossings could be avoided if all the wells and all new road construction were restricted to the northeast side of the creek and outside of the WIZ. Road construction, stream crossings, and well locations as proposed in the WIZ would modify floodplains, increase sediment delivery, and impact water quality in a relatively undeveloped watershed.

For Alternative 5, the construction of almost 3 miles of new road adjacent to Goose Creek and into the Turkey Creek watershed creates watershed impacts to reach a well that could be accessed from a preexisting road in the Turkey Creek drainage.

Bull Creek

Alternatives 1, 2, 5, 6, and 7 would have the same impacts within the Bull Creek watershed. Large watershed impacts from high road densities would occur with all alternatives, especially when compared to the current undeveloped state of the mid and upper watershed. Bull Creek and the majority of Little Bull Creek would have new road construction adjacent to the entire length of these streams. Field examination verifies that many new road stream crossings, road crossings of side tributaries (approximately 26 road crossings in 2 miles), and substantive construction within the WIZ would be necessary if the road were built as proposed. In many sections of the canyon, the valley bottom is so narrow that the road would likely encroach in the stream floodplain and channel. Road construction as proposed in the WIZ would modify floodplains, increase sediment delivery, and impact water quality to a high degree in a watershed that is largely undeveloped. Bull Creek is an alternately perennial and intermittent stream that flows directly into the Piedra River. Construction-derived sediment delivered to Bull Creek would likely also route into the Piedra River, a perennial fish-bearing river.

3.6.3.9.2 Squaw Creek, Wagon Gulch, Blind Gulch, Fosset Gulch and Turkey Creek

Fosset Gulch and Turkey Creek are alternately perennial and intermittent streams with dense riparian vegetation in places. Upper Squaw Creek, Wagon Gulch, and Blind Gulch are small intermittent watersheds within the Project Area. Squaw Creek, Fosset Gulch, Turkey Creek, and Wagon Gulch all have irrigated agriculture, roads, and scattered homes in the valley bottoms. Blind Gulch is largely undeveloped, with one minor road in the valley.

Alternative 2 would result in the largest impacts to Squaw Creek, Wagon Gulch, and Fosset Gulch compared to the other alternatives due to road construction and wells that are proposed to be located in the WIZ. New roads and wells are planned within the WIZ and on steep, erosive soils within Fosset Gulch. These facilities would likely result in increased sediment delivery to streams and cause the highest degree of floodplain and riparian impacts. New facilities potentially constructed in the WIZ include one new well in Wagon Gulch, one new well in Turkey Creek, one new compressor station in Blind Gulch, and three compressor stations in Fosset Gulch. Compressor stations are large permanent facilities,

which if built within floodplains adjacent to streams would present a high risk of direct watershed impact due to increased erosion, and subsequent sediment delivery to streams, increased risk of spills into streams, and floodplain modification. Mitigation could include relocating the Fosset Gulch compressors outside the WIZ, thereby reducing impacts to the stream. As proposed, the high level of new construction in Fossett Gulch would result in sedimentation, floodplain modifications, and potential riparian modifications. Fossett Gulch is an alternately perennial and intermittent stream that flows directly into the Piedra River. Construction-derived sediment delivered to Fossett Gulch would likely also transport to the Piedra River.

Alternatives 1 and 7 would have slightly lower watershed impacts compared to Alternative 2 but overall impacts to Fossett Gulch, and Wagon Gulch would still be high, and impacts to Blind Canyon and Turkey Creek would be moderate due to less new construction. Alternatives 1 and 7 propose compressor station construction in the WIZ of Fossett Gulch and Blind Canyon. As proposed, the high level of new construction in Fossett Gulch would result in sedimentation, floodplain modifications, and potential riparian modifications. Construction-derived sediment delivered to Fossett Gulch would likely also transport to the Piedra River.

Alternatives 5 and 6 would have the lowest watershed impacts compared to other alternatives. No activities are proposed for Wagon Gulch or Blind Canyon. Impacts to Turkey Creek would be moderate in Alternative 6 and there would be no new activity in Alternative 5. Two compressors are proposed in the WIZ in Fossett Gulch in Alternative 6 resulting in the same sedimentation issues as discussed above in Alternative 2.

3.6.3.9.3 Pole Creek

Upper Pole Creek watershed is undeveloped and has wet meadows and well developed riparian areas. Landslides are present on steep slopes in the watershed. The lower watershed has irrigated agriculture and roads.

All alternatives propose similar activities including the construction of two new wells and approximately 0.5 miles of new road within the WIZ. This new construction could modify floodplains and riparian areas and would increase sediment delivery to channels. Overall watershed impacts would likely be moderate, although alternate road locations outside of the WIZ are both possible and preferable.

3.6.3.9.4 Summary

All action alternatives would result in either localized or overall high impacts to the Lower Piedra watershed. More new construction is proposed in this watershed than any other in the Project Area under Alternatives 1 and 2. Impacts would be greatest in the Ignacio and Little Squaw for Alternatives 1 and 2. Impacts would be very high in the Bull Creek and Goose Creek watersheds under all alternatives. The greatly increased sedimentation impacts to Bull Creek and Goose Creek are expected to also negatively affect the Piedra River.

Road construction in the WIZ and in floodplains and riparian areas would be very high in this watershed, ranging from a total of 7.53 miles for Alternative 2, to 3.43 miles for Alternative 5 (Table 3-27). High erosion rates within the WIZ would be expected to deliver sediment to surface drainages, even with mitigation measures. Existing soil loss from CBM development is approximately 1,650 tons/year (Table 3-41). New construction would increase short-term surface sediment production by 940 tons/year to 2,590 tons/year total in Alternative 5 and by 5,360 tons/year to 7,012 tons/year total in Alternative 2 (Table 3-44and Table 3-45). These figures do not include potential large sediment contributions from landslides or potential produced water pipeline failures. Total impacts from road construction would also be high, ranging from 79 miles of new road for Alternative 2 to 19 miles of new road construction for Alternative 5 (Table 3-24).

Compared with any other watershed in the Project Area, more road construction on steep, unstable areas would occur in the Lower Piedra watershed. New road and pipeline construction over existing or high landslide hazard areas ranges from 18.3 miles for Alternative 2 to 1.7 miles for Alternative 5. Large volumes of sediment from potential pipeline failures and construction-derived surface erosion would have a moderate to high potential of reaching streams in the Ignacio and Little Squaw sub-watersheds for Alternatives 1, 2 and 7.

3.6.3.10 CBM Development, Irrigation Water Quality and Fugitive Dust

3.6.3.10.1 Alternative 1 — Proposed Action

The quality of irrigation water conveyed in open channels could be affected in the short term if they were adjacent to or along the ROW corridor where construction of well pads, pipelines, and roads would occur. These waters could also be affected over the long term by vehicular traffic on roads with native surfaces. Facility construction and operation would reduce vegetative cover and increase emissions of fugitive dust.

Dust settling in the open channels conveying irrigation waters could increase suspended sediment loads, turbidity, and potentially other constituents that would be associated with the sediments. Stream segments downstream of the Project Area that provide irrigation water and that are currently impacted by sedimentation could be affected over the short term by Alternative 1, but irrigation waters are not expected to be degraded over the long term.

BMPs would include locating well pads, roads, and pipeline corridors away from open channels and irrigation diversions and using dust inhibitors on the surfaces of roads that could cause emissions of fugitive dust. Dust suppression techniques would be used according to COGCC or other State or federal requirements. The CDPHE Air Pollution Control Division requires land-developing projects to prepare and implement a fugitive dust control plan. This requirement applies to land development that lasts longer than 6 months and encompasses a total area of 25 acres or more, and would most likely be necessary under Alternative 1.

Roads, pipelines, or well pads constructed within or across waters of the U.S., which could include irrigation ditches or canals, would require USACE Section 404 permitting under the Clean Water Act. Drainages must exhibit a bed and

bank and a definable channel with a connection to a downstream stream or river to be considered waters of the U.S. Whether permits are required would be decided on a site-specific basis at the APD level of analysis. If construction occurs within or traverses irrigation ditches or canals, it would be subject to Section 404 permitting requirements, and mitigation measures would be necessary to protect the quality of irrigation water.

3.6.3.10.2 Alternative 2 through Alternative 7

The environmental effects of the other alternatives are expected to be similar to Alternative 1, with Alternative 2 having somewhat more impact than Alternative 1, and Alternatives 6 and 7 having somewhat less. Alternative 5 has the least road building and construction and would also have the lowest impact compared to other alternatives.

3.6.3.11 Effects on Surface Water Flows and Associated Riparian Areas, Wetlands, Springs, and Seeps

Dewatering the Fruitland Formation for methane gas development would intercept groundwater discharge to local rivers, thus decreasing streamflow. Dewatering the Fruitland Formation would also have the potential to dewater seeps, springs, and wetland areas on the outcrop.

3.6.3.11.1 Alternative 1 — Proposed Action

Dewatering the Fruitland Formation would result in long-term depletions to surface water flows by intercepting groundwater discharges to streams, springs, and seeps in the Project Area. Potential impacts to surface flows from dewatering depend primarily on the proximity of the drill sites to a river, spring, or seep, and on the pathway for groundwater discharge to these surface water features.

Historical discharge to the combined Animas, Florida, Pine, and Piedra Rivers is an estimated 194 acre-feet/year from the Fruitland Formation (Cox et al. 2001). CBM development to date has intercepted groundwater and depleted surface flows from these drainages. As of 2001, an estimated 65 acre-feet/year in surface flows was being lost to the Animas, Pine, and Florida Rivers.

Loss of surface flows from the Animas, Pine, and Florida Rivers is estimated to equal approximately 140 acre-feet/year over the next 30 to 50 years as a result of CBM development that has occurred to date. In other words, the wells currently in production will continue to operate and deplete surface water flows independent of the new wells proposed from this project.

It is not anticipated that CBM infill wells proposed with this project will increase or accelerate surface water depletions by a significant degree in the Animas and Los Pinos drainages. Infill wells may cause additional increased depletions of approximately six acre-feet/year in the Florida River, resulting in a total estimated loss of 13 acre-feet/year over the long term.

The effect of existing development on volumes of groundwater discharge to the Piedra River is unknown; however, future depletions of 15 to 60 acre-feet/year from the wells proposed with this project may occur.

The comparison of groundwater discharge with measured base flows and predicted maximum depletions in three of the aforementioned streams is shown on Table 3-30.

Table 3-30 Comparison of Fruitland/Pictured Cliffs Discharge with Measured Base Flows

Stream	Measurement Location	Period of Record	Measured Baseflow (acre-feet/year)	Estimated Baseline Fruitland Discharge (acre-feet/year)	Estimated Maximum Depletion from CBM (acre-feet/year)
Animas River	Animas River near Durango	1987–1998	144,793	66	66
Pine River	Pine River near Bayfield	1975–1986	36,198	61	61
Florida River	Florida River near Durango	1950–1960	7,240	17.5	13

Source: Cox et al. 2001

Riparian and wetland areas near the larger rivers are not likely to be affected by Alternative 1 CBM development because the total amounts of water depletions to the rivers are not expected to cause dry channel conditions. Springs and seeps situated along the Fruitland and Pictured Cliffs outcrops may be affected by dewatering of the Fruitland Formation. Potential impacts would depend on the proximity of the drill sites to these features. Areas with concentrated CBM wells could be adversely affected by reduced or eliminated surface flows and subsequent drying up of springs, seeps, and loss of associated vegetation. The FS and BLM started monitoring some springs on the Fruitland outcrop in 2005 to document the magnitude of future changes due to CBM development should they occur (See Section 3.5.10 monitoring).

Spring flow may also be inhibited locally if compaction occurs during construction or production. Well construction could diminish the utility of these seeps and springs for domestic, irrigation, or stock watering supplies. In accordance with BLM and FS guidelines, proposed wells would be relocated during the APD stage to avoid construction in wet areas.

Alternative 1 would remove more groundwater from the coal seams during CBM development than could be naturally recharged. Surface water depletions due to dewatering of the Fruitland Outcrop would continue over the life of the project or longer. If surface water/groundwater interactions can return to pre-development conditions, this process may take several centuries.

3.6.3.11.2 Alternative 2

Under Alternative 2 — Maximum development, the environmental effects would be similar to Alternative 1, but would be proportionally greater in the Florida River and Piedra River areas because of the increased rate of aquifer dewatering caused by additional well development.

3.6.3.11.3 Alternative 5 — No Action

Reductions in surface water flows of the Animas, Pine, and Florida Rivers would be as described for Alternative 1. Depletions to the Piedra River would not occur except in limited instances, and the environmental effects would be less than under Alternative 1, because CBM development would not intercept groundwater that normally discharges to this river.

3.6.3.11.4 Alternative 6 and 7

The environmental effects of Alternative 7 would be similar to Alternative 1 and greater than Alternative 5 due to the similar development regimes of the two alternatives.

3.6.3.12 Consumptive Water Uses, Water Rights, and CBM Well Production

There are two types of consumptive water uses associated with CBM development. First, water is needed to drill wells and build well infrastructure. Second, water is used up in the process of extracting methane gas. Water that would normally flow from the Fruitland Formation into rivers, springs and seeps, would be intercepted, extracted, and re-injected into deeper aquifers.

The water requirements for CBM well drilling and for construction of roads, pipelines, and compressor stations are summarized on Table 3-31. Water volumes were calculated as described in Chapter 2.

Table 3-31 Well Drilling and Well Construction Water Requirements for All Alternatives

	Alternative				
	1	2	5	6	7
Total Water Requirement (acre-feet)	150	260	60	100	140
National Forest Water Requirements	90	145	0	40	75
BLM Water Requirements	6	11	0	6	6

The water that would be lost to the Animas, Florida, Pine, and Piedra Rivers by dewatering the Fruitland Formation is summarized on Table 3-32, and displayed graphically in Figure 3–28.

Table 3-32 Long-Term Maximum Water Depletions to Area Rivers Resulting from Dewatering the Fruitland Formation

	Depletion by Alternative (acre-feet/year)				
Stream	1	2	5	6	7
Animas River	66	66	66	66	66
Florida River	13	13	5	13	13
Piedra River	15–60	15–60	0	0	15–60
Pine River	61	61	61	61	61
Total	200	200	132	132	200

Source: Cox et al. 2001

3.6.3.12.1 Alternative 1 — Proposed Action

Dewatering of the Fruitland Formation is necessary to extract methane gas. Dewatering this aquifer would result in estimated annual surface water losses of about 140 acre-feet/year from the Florida, Pine, and Animas Rivers, and 15 to 60 acre-feet/year from the Piedra River. Surface water losses would continue for several centuries (Cox et al. 2001). These depletions could affect existing water rights because less surface flow would be available than has been present historically.

Water needed to drill wells in Alternative 1 would consume approximately 150 acre-feet of water over the life of the project (90 acre-feet as a result of National Forest CBM development and approximately 6 acre-feet as a result of BLM development). The operators could purchase water from a variety of users, resulting in minor shifts in water consumption from existing uses to this project. As an example, if all of the water were obtained from agricultural sources, approximately 0.03 percent of the irrigation use in La Plata and Archuleta Counties could shift to industrial use for this project. The companies could purchase the water from current users with existing water rights. The companies would also have the option to apply for water rights for this identified use.

3.6.3.12.2 Alternatives 2, 5, 6, and 7

The environmental effects of all other alternatives with respect to dewatering the Fruitland Formation and reducing surface water flows are not expected to vary much from Alternative 1 in the Animas, Pine, and Florida drainages. For Alternative 5 and 6 depletions in the Piedra River would be less than under than under other alternatives because CBM development would not intercept as much groundwater that normally discharges to the surface. Approximately 0.03 percent of the irrigation use in La Plata and Archuleta Counties could shift to industrial use to satisfy drilling needs. The estimated amount of water utilized for CBM development is presented on Table 3-31.

3.6.3.13 Beneficial Use of CBM Produced Waters

3.6.3.13.1 All Alternatives

As of December 1998, 244 million barrels or 28,900 acre-feet of water have been produced from the Fruitland Formation (Questa 2000). Water production associated with CBM development currently varies across the Project Area. CBM wells

have produced from 4 barrels per day in the eastern portion to 75 barrels per day in the western portion.

CBM wells proposed under Alternative 1 could generate from 0.2 to 3.5 acre-feet/year of produced water per well. This water could be available to support beneficial use, which could include irrigation, stock watering, fugitive dust control, and wildland fire fighting. The beneficial use of produced waters depends on quality, and would require additional analysis and permitting. Produced water from the Fruitland Formation is marginal to poor quality (1,000 to 10,000 mg/L of TDS), but varies within the Project Area (Cox et al. 2001). Water quality is often much better approaching the Fruitland Outcrop groundwater recharge area.

Surface discharge of produced waters is not currently proposed, and for this reason, has not been analyzed in detail with this project. Some companies are evaluating and testing discharge to surface waters. The suitability of CBM produced water for surface discharge and the limitations on use based on water quality would be established in site-specific NPDES discharge permits. Surface discharge of CBM produced waters could degrade water quality if the discharge did not adhere to the requirements in permits or the associated limitations were exceeded. Pre-treatment of the produced waters would most likely be necessary to meet the required standards. Treatment methods could include reverse osmosis, ion exchange, or a combination of both. Produced water discharged to surface drainages would be available for appropriation and diversion under SEO regulations.

Impoundments may also be constructed to treat, dispose of, or provide for beneficial use of higher quality produced waters. Impoundments constructed in upland areas in the Project Area could disperse livestock and wildlife and offer the benefit of better use of forage and reduced overgrazing and erosion. Produced water proposed for beneficial use would require an application for a well permit to be filed with the SEO that designates the type of use. Pre-treatment may be needed to amend the quality of CBM produced water to meet criteria specific to and to support the intended use.

3.6.3.14 Cumulative Effects of CBM Development on Water Quality, Fugitive Dust, Surface Water Depletions, Consumptive Uses, and Water Rights (and any other issue addressed in Environmental Consequences)

Cumulative effects to surface waters include the effects of past, present, and reasonably foreseeable projects. The size of the area considered for cumulative impacts varies based on the impacts (chemical, physical changes, etc) to the resource. Unless specified in a section below, the cumulative effects analysis area encompasses that portion of the Upper SJB fourth-level watershed (USGS Hydrologic Unit Code [HUC] 14080101) and the Piedra River fourth level watershed (USGS HUC 14080102) above Navajo Dam in New Mexico, and the Animas fourth-level watershed (USGS HUC 14080104) above Bloomfield, New Mexico.

The cumulative effects analysis area for watershed encompasses a larger land area than the Project Area that was the focus of direct and indirect effects.

3.6.3.15 Surface Water Quality —Cumulative Chemical Contamination as a Result of Spills

Surface water quality in the cumulative effects area of each watershed could be degraded by accidental spills of petroleum products, produced water, or drilling fluids. Under all action alternatives, effects from accidental spills due to vehicle refueling operations, a breach in pipelines, or mishandling of hazardous material could occur anywhere in the cumulative effects area.

The areas of greatest concern for future potential spills occur where pipelines are constructed over pre-existing landslides or over high landslide hazard areas. Table 3-33 summarizes the total miles of new pipeline construction in landslide hazard areas or on pre-existing landslides.

Table 3-33 Total Miles of New Pipeline Construction in Landslide Hazard Areas or on Pre-existing Landslides for All Alternatives

	Length of Pipeline in Landslide Hazard Areas or on Pre-existing Landslides by Alternative (miles)				
Location	1	2	5	6	7
Project Area	19	41	3	4	9
National Forest	17	35	2	3	7
BLM	1	3	0	1	1

In general, landslide hazard areas occur within 1.5 miles of the Fruitland outcrop and in the more mountainous eastern half of the Project Area. Cumulative impacts would be difficult to predict, but would be greatest if one or more pipeline failures occurred simultaneously in the same watershed. Very wet weather conditions such as winters with above average snow water content, or wetter than average summers could provide conditions that favor the triggering of landslides that may lead to multiple failures of pipelines.

The impacts associated with hazardous waste could have cumulative effects only if they were improperly handled (spilled) or left on-site. If this were to occur at several sites, there would be a cumulative effect. However, cumulative impacts to water quality would be minimized if material handling requirements, federal and state water quality regulations, BMPs and mitigation measures were implemented (Appendix F).

For those well locations near surface drainages, accidental releases of drilling fluids caused by failure or an overflow of the pit could traverse the well pad and migrate into the surface drainages. Additionally, the more well construction within the WIZ, the higher the cumulative risk for spills to impact water quality. Constructing an adequate berm around the perimeter of the well location could significantly minimize the chances for these spills to reach those drainages. Al-

ternatives 1 and 2 have the highest number of wells constructed within the WIZ and therefore have the highest potential cumulative risk that accidental spills or releases would reach streams.

Reserve pits are normally a part of a well site, and are used for storage or disposal of water, drill mud, and cuttings. Pits improperly constructed can result in failure. Well locations within the WIZ have a greater chance of pit failure than those outside the WIZ due to potential flood events. During flood events, the spoils of the pit could overflow and enter into surface drainages. The cumulative risks associated with pit failure and any contaminants reaching surface drainages are high with well pad construction within the WIZ. Alternatives 1 and 2 have the highest number of wells constructed within the WIZ and therefore have the highest potential cumulative risk that flood events would result in pit failure and drilling fluids and liquid waste would reach streams

These short-term impacts would occur during the construction, drilling, and completion phases of well pad development. For the Project Area, the proposed well pad density inside and outside the WIZ is greatest for Alternatives 1 and 2. Therefore, the cumulative impacts to water quality from these spills throughout the Project Area under Alternatives 1 and 2 would be greater than the effects for all other action alternatives. Alternative 5 would have the lowest impacts because fewer wells overall are proposed in the WIZ.

3.6.3.16 Surface Water Quality Cumulative Effects—Physical Changes as a Result of Well Pad, Road, and Pipeline Construction

The watershed cumulative effects analysis area was extended upstream on the main rivers far enough to assess if the rivers were heavily impacted when they entered the Project Area. The cumulative effects analysis area was extended downstream to where the effects of CBM development became minimal compared to the whole watershed (See Appendix M for further discussion of the upstream and downstream terminus of the cumulative watershed effects analysis area, and description of the analysis.) The Project Area includes or touches part of thirteen (13) 6th level watersheds. In total, forty-four (44) 6th level watersheds were assessed encompassing 764,600 acres.

The activities analyzed in the cumulative effects analysis are activities that disturb soil or vegetation, including past and present roads, fires, timber and fuel treatments, mining, and construction activities across all ownerships. The proposed action, Alternative 1, was used for detailed analysis and additional analysis was conducted using Alternative 2 (maximum development). For reasonably foreseeable actions, proposed Forest and BLM management actions and infill well applications on all ownerships were used. Since some activities recover over time, impacts were modeled at three-year intervals terminating in 2024.

The analysis process is an assessment of acceptable watershed risk, not a projection of probable physical or geomorphic effects. Cumulative effects can be either on-site or off-site. Activities that could result in on-site effects include, for example, facility construction or redisturbing an area before ground cover or soil compaction has recovered from the initial disturbance. Off-site effects could include

the incremental increases in water yield from several, closely timed timber harvests or the incremental accumulation of sediment in a 4th or 5th order stream from several individually insignificant activities in the upstream portions of the drainage network.

The results of the cumulative watershed analysis are displayed in tabular form in Table 3-34. To determine the point where detectable negative cumulative effects could occur, a threshold of 20 percent of any watershed being impacted by activities rated high or moderate impact was used. If less than 20 percent of the watershed had high or moderate impact activities, the risk of negative cumulative watershed effects was considered low. The results of the analysis show that no watersheds within the Project Area will be above the 20 percent impact threshold, considering past, proposed and reasonably foreseeable actions.

Three watersheds above the Project Area, the Middle Los Pinos-Red Creek, Upper Animas Valley-Trimble, and Upper Florida River-Red Creek, have been impacted by the Missionary Ridge Fire, and are shown as being above the 20-percent threshold for the first time period. These fire-related impacts are diminishing, and portions of these watersheds have had rehabilitation. No watersheds downstream exceed the threshold, so CBM development impacts will not add to any unacceptable risks downstream.

No 6th level watershed with CBM development activities is expected to have detrimental cumulative effects; impacts for both Alternative 1 and Alternative 2 were below threshold. Alternatives 5, 6, and 7 would result in impacts that are less than Alternative 1, and would also be under threshold. CBM activities, in conjunction with past and reasonably foreseeable activities, are below the threshold where risk of cumulative watershed effects is expected for each 6th level watershed where CBM activities are proposed. Stollsteimer Creek is approaching the threshold, and is also being evaluated by State of Colorado for sediment impacts. If Stollsteimer Creek is found to be impaired by sediment additional mitigation beyond that specified in this EIS may be required.

The sixth level watersheds below the Project Area are not over threshold, and the receiving water bodies in New Mexico (Animas River and Navajo Reservoir) are not listed as being impaired by sediment. CBM development activities are not expected to have detrimental cumulative effects in the context of the larger watersheds of the Animas River, the Los Pinos River, or the Piedra River.

This cumulative effects analysis does not account for the particular locations of disturbances within the watershed. A watershed that is within the cumulative effects threshold can still have undesirable effects from particular activities in streamside zones or on unstable slopes. These effects are discussed in the direct and indirect effects analysis (Sections 3.6.3.2 through 3.6.3.9). Given that a large portion of the modeled existing "high impact acres" are roads and well pads, restriction of new construction in streamside zones and unstable slopes is desirable.

Table 3-34 Portion of Watershed with High and Moderate Impact Activities for Past, Present, and Reasonably Foreseeable Activities Compared to Cumulative Effect Threshold of 20 Percent

HUC 6 #	HUC 6 name	Portion of Watershed with High or Moderate Impact Activities by Year (percent) 2006	2009	2012	2015	2018	2021	2024
140801011001	Sandoval Canyon	14.8	14.5	14.5	14.5	14.5	8.4	8.4
140801011002	Navajo Reservoir Inlet-San Juan River	2.0	2.0	2.0	2.0	2.0	2.0	2.0
140801011003	Sambrito Creek	3.3	3.3	3.3	3.3	3.3	3.3	3.3
140801011501	Middle Los Pinos River-Red Creek	84.4	2.9	1.0	1.0	1.0	1.0	1.0
140801011502	Bear Creek	1.2	1.3	0.9	0.9	0.9	0.9	0.9
140801011503	Los Pinos River-Bayfield	4.3	4.3	3.4	3.4	3.4	3.2	3.2
140801011601	Upper Beaver Creek	6.7	6.5	3.6	3.0	1.6	1.6	1.6
140801011602	Middle Beaver Creek	4.0	9.4	2.2	2.2	2.2	2.2	2.2
140801011603	Lower Beaver Creek	2.7	2.1	2.1	2.1	2.1	2.1	2.1
140801011701	Dry Creek	6.8	3.5	3.5	3.5	3.5	3.5	3.5
140801011702	Los Pinos River-Rock Creek	4.8	4.8	4.8	4.8	4.8	4.8	4.8
140801011703	Ute Creek	10.5	3.1	3.1	3.1	3.1	3.1	3.1
140801011704	Upper Spring Creek	2.8	2.8	2.8	2.8	2.8	2.8	2.8
140801011705	Lower Spring Creek	4.7	4.7	4.7	4.7	4.7	4.7	4.7
140801011706	Lower Pinos River-Shellhammer Ridges	6.0	6.0	6.0	6.0	6.0	6.0	6.0
140801011801	Los Pinos River-La Boca Canyon	5.5	5.5	5.5	5.5	5.5	5.5	5.5
140801012204	Trail Canyon	8.9	6.5	6.3	6.3	6.3	6.3	6.3
140801020301	Upper Devil Creek	3.1	5.2	2.2	2.2	2.2	2.2	2.2
140801020302	Lower Devil Creek	8.9	8.4	8.4	5.0	5.0	5.0	5.0
140801020401	Martinez Creek-Dutton Creek	18.4	12.5	2.4	2.4	1.9	1.6	1.6
140801020402	Upper Stollsteimer Creek	19.0	17.3	15.5	15.5	15.5	15.3	15.3
140801020403	Stollsteimer Creek-Dyke Valley	7.1	7.2	6.2	6.2	6.2	6.2	6.2
140801020404	Middle Stollsteimer Creek	14.7	5.5	5.5	3.3	3.3	3.3	3.3
140801020405	Lower Stollsteimer Creek	1.7	2.7	2.5	1.5	1.5	1.5	1.5
140801020501	Yellowjacket Creek	15.6	18.9	2.3	2.1	1.9	1.9	1.9
140801020502	Piedra River-Stollsteimer	2.6	2.6	2.6	2.6	2.6	2.6	2.6
140801020503	Piedra River-Navajo Reservoir Inlet	2.0	1.9	1.9	1.9	1.9	1.9	1.9
140801040504	Upper Animas Valley-Trimble	33.5	5.3	5.3	5.2	5.2	5.0	5.0
140801040601	Junction Creek	10.2	6.5	6.5	6.3	6.3	6.3	6.3
140801040602	Upper Lightner Creek	16.6	16.0	0.4	0.4	0.4	0.4	0.4
140801040603	Lower Lightner Creek	2.3	2.3	2.3	2.3	2.3	2.3	2.3
140801040604	Animas River-Spring Creek	7.5	5.5	5.5	5.5	5.5	5.3	5.3
140801040701	Middle Animas Valley-Smelter Mountain	7.5	7.5	7.5	7.5	7.5	7.5	7.5
140801040702	Basin Creek	3.6	4.0	2.7	2.7	2.7	2.7	2.7
140801040703	Middle Animas Valley-La Posta	4.0	4.0	4.0	4.0	4.0	4.0	4.0
140801040704	Middle Animas Valley-Bondad	5.7	5.7	5.7	5.7	5.7	5.7	5.7
140801040804	Upper Florida River-Red Creek	59.1	2.2	2.2	2.2	2.2	2.2	2.2
140801040901	Lower Florida River-Ticalotte	3.7	3.6	3.6	3.6	3.6	3.6	3.6
140801040902	Lower Florida River-Cottonwood Gulch	4.0	4.0	4.0	4.0	4.0	4.0	4.0
140801040903	Lower Florida River-Salt Creek	6.4	4.2	4.2	4.2	4.2	4.2	4.2
140801040904	Lower Florida River-Cow Canyon	6.9	6.9	6.9	6.9	6.9	6.9	6.9
140801041001	Cox Canyon	4.3	4.3	4.3	4.3	4.3	4.3	4.3
140801041002	Hat Park Canyon	5.0	5.0	5.0	5.0	5.0	5.0	5.0
140801041003	Animas River-Six Shooter Canyon	4.7	4.7	4.7	4.7	4.7	4.7	4.7

3.6.3.17 Irrigation and Fugitive Dust cumulative effects

Under Alternative 1, cumulative effects on the quality of irrigation water from fugitive dust are expected to be minimal because dust suppression measures would be used during development, so the generation of fugitive dust would be low during operation.

Cumulative effects to the quality of irrigation water from fugitive dust under Alternative 2 would be greater than the effects discussed for Alternative 1 because of the higher level of development in the Project Area. Alternatives 5, 6, and 7 would result in fewer cumulative effects than Alternatives 1 and 2.

3.6.3.18 Surface Water Depletions and Dewatering of the Fruitland Formation

Cumulatively, existing and future development of oil and gas resources would result in a loss of ground-water discharge from the Fruitland Formation to the Animas, Pine, Florida, and Piedra rivers as well as some streams in the Project Area (Questa 2000, Cox et al. 2001). This would result in a loss of flow in rivers within and downstream of the Project Area. These losses occur as a result of CBM wells extracting, water from the Fruitland Formation down dip of the Fruitland outcrop and recharge area. The CBM-produced water is subsequently lost to the local ground-water system because it is re-injected into the Dakota and Entrada Formations/aquifers at depths considerably deeper than the Fruitland Formation.

Given the interconnected nature of the Fruitland Formation aquifer, development within the Southern Ute Reservation, south and down dip of the Project Area would contribute to a lesser degree to depletions from the Animas, Pine, and Florida Rivers plus possibly Texas Creek.

CBM development in the Farmington EIS planning area would not contribute to water depletions in the Project Area because this development is much deeper in the San Juan Basin, and is far from the Fruitland outcrop, recharge areas and areas of groundwater discharge.

Existing CBM development contributes to most of the existing and projected surface water depletions (Questa 2000, Cox et al. 2001) except for depletions in the vicinity of the Piedra River. The 3M model (Questa 2000) and Cox et al. (2001) estimate that approximately 60 acre-feet per year could be depleted from the Piedra River as a result of new development in the eastern portion of the Project Area.

The cumulative effects of existing and future development of oil and gas resources may also cause a loss of flow in springs and seeps along the Fruitland Formation and Pictured Cliffs Sandstone outcrops. Potential impacts would depend on the proximity of the cumulative proposed drill sites to these features.

Cumulative effects from surface water depletions and dewatering under Alternative 2 would be greater than the effects discussed for Alternative 1 because of the

higher level of development in the Project Area. Alternatives 7, 6, and 5, in descending order of impact, would all result in less cumulative effects from surface water depletions than Alternatives 1 and 2.

3.6.3.19 Consumptive Use and Water Rights

Water would be consumed for drilling throughout the cumulative effects area as a result of the drilling of approximately 1,600 new wells. Cumulative effects associated with Alternative 1 consider the consumptive use of water supplies for existing and proposed oil and gas development in the Project Area within the bounds of the Southern Ute Reservation. The projected consumption from the SUIT EIS is 535 acre-feet or 27 acre-feet per year. Thus, the cumulative annual consumption of surface water supplies, including this project, would equal approximately 40 acre-feet per year. Surface waters in the cumulative effects analysis area should not be reduced in quantity because the water requirements for well drilling and completion would be acquired from already appropriated irrigation sources.

Water consumed from drilling and completing CBM wells under Alternative 2 would be greater than the effects discussed for Alternative 1 because of the higher level of development in the Project Area. Alternative 5, 6, and 7 would result in less consumptive use of surface water resources than Alternatives 1 and 2.

Dewatering of the Fruitland Formation is necessary to extract methane gas. Dewatering this aquifer would result in estimated annual surface water losses of about 140 acre-feet/year from the Florida, Pine, and Animas Rivers, and 15 to 60 acre-feet/year from the Piedra River. Surface water losses would continue for several centuries (Cox et al. 2001). CBM development activity on the Southern Ute Indian Reservation (approximately 1,300 new wells) is projected to intercept about 37 acre-feet of discharge to the Animas River (ibid).

3.6.3.20 Beneficial Use of CBM Produced Waters Cumulative Effects

Cumulative effects from the beneficial use of CBM produced waters have not been realized because surface discharge has not occurred to any great extent within the cumulative effects area.

3.6.4 Mitigation and Monitoring

3.6.4.1 Mitigation, BMPs and Applicable Forest Plan Standards and Guidelines

The following are recommended standard mitigation measures to reduce CBM development effects to surface water quality, quantity, and use. Unless otherwise stated, the operators will fund the measures. Also refer to mitigation and monitoring sections in Chapters 3.3 and 3.5. Effectiveness for the majority of mitigation measures is documented in FSH 2509.25.

Road Location and Construction — project-wide application required:

- Locate roads and trails outside riparian areas unless alternative routes have been reviewed and rejected as being more environmentally damaging (Forest Plan – MA 9A Transportation System Management – L01, L02, 01).
- Use existing roads unless other options will produce less long-term sediment. Reconstruct for long-term soil and drainage stability (FSH 2509.25 13.1 (9) 1.f, 2006).
- Construct roads on ridgetops, stable upper slopes, or wide valley terraces if practicable. Stabilize soils onsite. End-haul soil if full-bench construction is used. Avoid slopes steeper than 70 percent (FSH 2509.25 13.1 (9) 1.a, 2006).
- Maximum road grades are 8 percent, except for short pitches up to 12 percent for 300 feet or less. .Consider steeper grades in those situations where they result in lesser environmental impact.
- Locate and construct arterial collector roads to maintain the basic natural condition and character of riparian areas (Forest Plan – MA 9A F03, 05).
- Do not parallel streams when road location must occur in riparian areas except where absolutely necessary. Cross streams at right angles. Locate crossings at points of low bank slope and firm surfaces (Forest Plan – MA 9A Transportation System Management – L01, L02, 01 S&G a.).
- Maintain the natural width to depth ratio of the stream at the channel crossing.
- Establish vegetation groundcover on disturbed areas (excluding running surface) to at least 60 percent within two years. On low productivity sites, establish to at least 40 percent groundcover. Restore groundcover using native plants as practicable to meet revegetation objectives. Avoid persistent or invasive exotic plants (Forest Plan – MA 9A Transportation System Management – L11, L12, L13, 02 S&G a; FSH 2509.25 13.4 (12) 1.d, 2006).
- Drain and restore roads, pads, and drill sites immediately after use is discontinued. Revegetate to 80 percent of groundcover in the first year. Provide surface protection during storm-flow and snowmelt runoff events (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02 S&G b; FSH 2509.25 13.4 (12) 1.a, 2006).
- Schedule construction activities during dry periods or low water periods (Forest Plan – MA 9A Transportation System Management – L11, L12, L13, 04; FSH 2509.25 13.1 (9) 1.b, 2006).
- Incorporate structures which provide for fish passage in all new roads and trails crossing perennial streams which support a fishery (Forest Plan – MA 9A F03, 06).
- Gravel all roads during or immediately after construction unless a site-specific exception is granted.
- Consider using drain dips (water bars) on roads that have gradients less than 10 percent and avoid dips on road gradients over 10 percent.

- Design all roads, trails and other soil disturbances to the minimum standard for their use and to "roll" with the terrain as feasible (FSH 2509.25 13.2 (10) 1.a, 2006).
- Design road ditches and cross drains to limit flow to ditch capacity and prevent ditch erosion and failure (FSH 2509.25 13.2 (10) 1.f, 2006).
- Install cross drains to disperse runoff into filter strips and minimize connected disturbed areas. Make cuts, fills, and road surfaces strongly resistant to erosion between each stream crossing and at least the nearest cross drain. Revegetate using certified local native plants as practicable; avoid persistent or invasive exotic plants (FSH 2509.25 13.1 (9) 1.c, 2006).
- Construct roads where practicable with outslope and rolling grades instead of ditches and culverts (FSH 2509.25 13.1 (9) 1.d, 2006).
- Properly compact fills and keep woody debris out of them. Revegetate cuts and fills upon final shaping to restore ground cover, using certified local native plants as practicable; avoid persistent or invasive exotic plants. Provide sediment control until erosion control is permanent (FSH 2509.25 13.3 (11) 1.b, 2006; Forest Plan – MA 9A Transportation System Management – L11, L12, L13, 03).
- Recontour and revegetate all new roads determined to be excess to Forest and BLM road transportation needs to agency standards after the project is complete. Road stream crossings would be restored to original channel dimensions and grade. By closing as many new roads as possible, the density of open roads would be reduced as much as possible toward meeting LRMP standards and guidelines.
- Use dust control as needed to minimize the production of fugitive dust during the construction phase. Dust control during the production phase should be assessed on a site-specific basis and used as needed.

- For all new well pads located on Federal lands – Construct with maximum fill slope of 3:1 on all new pads, unless otherwise authorized by the FS/BLM. Construct berms or v-ditches around pad with a controlled drainage armored to prevent erosion. Filter or settle pad runoff water prior to entering any drainage using excelsior logs, settling ponds or other, but not straw bales. Vehicles with hydrocarbon leaks will use absorbent pads to prevent runoff into drainages.

- For new well pads on terrain steeper than 20 percent with erosive soils - Limit fill slope length, to the extent possible, to less than 10 feet or maintain slopes at or less than a 3:1 slope. Armor fills with 2- to 6-inch diameter rock and a minimum of 4 inches depth. Rock must be washed and from an agency inspected weed free source. Excelsior blankets (not erosion cloth) may also be used in conjunction with seeding and hydromulching. Install excelsior logs at toe of slope. Construct 12 inch minimum height berms or v-ditches around pad to prevent surface water from flowing over fill material. Construct armored ditch or berm drainage (2- to 6-inch diameter rock minimum 4 inches depth). Exceptions may be obtained during the APD permitting process with an agency approved erosion control plan.

- Pipeline construction that crosses ephemeral, intermittent, or perennial streams would require additional mitigation measures. Digging of new open trenches shall not occur more than one week prior to laying pipelines within 100 feet of stream crossings. Within one week post pipeline placement within 100 feet of stream crossings, open trenches must be backfilled, stabilized, and must provide adequate cross drainage

Culverts and Stream Crossings — project-wide application required:

- Install stream crossings to meet Corps of Engineers and State permits, pass normal flows, and be armored to withstand design flows (FSH 2509.25 12.2 (4) 1.a, 2006
- Size culverts and bridges to pass debris (FSH 2509.25 12.2 (4) 1.b, 2006).
- Install stream crossings on straight and resilient stream reaches, as perpendicular to flow as practicable, and to provide passage of fish and other aquatic life (FSH 2509.25 12.2 (4) 1.c, 2006).
- Install stream crossings to sustain bankfull dimensions of width, depth and slope and keep streambeds and banks resilient. Favor bridges, bottomless arches or buried pipe-arches for those streams with identifiable floodplains and elevated road prisms, instead of pipe culverts. Favor armored fords for those streams where vehicle traffic is either seasonal or temporary, or the ford design maintains the channel pattern, profile and dimension (FSH 2509.25 12.2 (4) 1.d, 2006).
- Install road-grade culverts in areas of excessive runoff and follow construction BMPs or those defined by the FS or BLM.
- Locate culverts or drainage dips in such a manner to avoid outflows onto unstable terrain such as slumps, side-cast fills, and headwalls. Provide adequate drainage features along a road prism to avoid accumulation of water in ditches or surfaces.
- Provide energy dissipators (i.e. rock weirs) at culvert outlets or drain dips where water is discharged onto loose or erodible material.
- Remove all temporary stream crossings (including all fill material in the active channel), restore the channel geometry, and revegetate the channel banks using certified local native plants as practicable; avoid persistent or invasive exotic plants (FSH 2509.25 13.4 (12) 1.b, 2006).

Riparian and Wetland Areas:

- Maintain at least 80 percent of potential groundcover within 100 feet from the edges of all perennial streams, lakes and other waterbodies, or to the outer margin of the riparian ecosystem, where wider than 100 feet. (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 04 S&G c).
- Discontinue heavy equipment use when soil compaction, rutting, and puddling are present (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G e).
- Locate drilling mud pits outside of active floodplains unless alternate locations are more environmentally damaging. If location is unavoidable,

seal and dike all pits to prevent leakage (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02 S&G a).

- Avoid crossings of stream, wetland, and riparian areas during construction of infrastructure (pipelines, roads, and power lines) to the extent practicable. In the event that a wetland or riparian area must be crossed or disturbed, additional (site-specific) mitigation will be required. The measures will be identified by a hydrologist and road engineer. These measures may include:
  - All crossings of wetlands and other waters of the U.S. should comply with the appropriate USACE regulations (for example, Nationwide Permits 12 and 14). If potential effects exceed the limits of the Nationwide Permits, Individual Permits should be obtained.
  - Reshape disturbed channels to their original configuration and properly stabilize.
  - Develop site-specific mitigation plans during the APD, plan of development, or Sundry Notice approval process for all proposed disturbance to wetlands and riparian areas.
  - Keep heavy equipment out of streams, swales, and lakes except to cross at designated points, build crossings, or to complete restoration work, or if protected by at least 1 foot of packed snow or 2 inches of frozen soil. Keep heavy equipment out of streams during fish spawning, incubation and emergence periods. Do not disrupt water supply or drainage patterns into wetlands (FSH 2509.25 12.1 (3) 1.b, 2006; Forest Plan-MA 9A Transportation System Management-L11, L12, L13, 04).
  - Limit construction in riparian areas, wetlands, and WIZ. Locate new concentrated use sites outside the WIZ, if practicable and outside riparian areas and wetlands. Armor or reclaim existing sites in the WIZ to prevent detrimental soil and bank erosion (FSH 2509.25 12.1 (3) 1.e, 2006; Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02).
  - Locate well drill-pads outside the WIZ (FSH 2509.25 15.1 (15) 1.a, 2006).
  - Do not excavate material from, or store excavated material in, any stream, swale, lake, wetland or WIZ (FSH 2509.25 12.1 (3) 1.m, 2006).
  - Do not encroach fills or introduce soil into streams, swales, lakes or wetlands (FSH 2509.25 13.3 (11) 1.a, 2006).
  - Prohibit the depositing of soil material from drilling, processing, or site preparation in natural drainageways (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G a).

- Locate the lower edge of disturbed or deposited soil banks outside of the active floodplain (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G b).
- Begin reclamation of disturbed wetlands and riparian areas (or replacement if necessary) immediately after project activities are complete.

➢ Road Construction and other disturbances in wetlands and riparian areas:

- Minimize the time and area of disturbance for road and pipeline at surface water crossings.
- Limit construction of well pads, roads, and pipelines on slopes greater than 30 percent.
- Keep roads and trails out of wetlands unless there is no other practicable alternative. If roads or trails must enter wetlands, use bridges or raised prisms with diffuse drainage to sustain flow patterns. Set crossings bottoms at natural levels of channel beds and wet meadow surfaces. Avoid actions that may dewater or reduce water budgets in wetlands (FSH 2509.25 12.4 (6) 1.b, 2006).
- When practicable, keep buried utility and pipelines out of wetlands. If such a line must enter a wetland, use measures that sustain long-term wetland function (FSH 2509.25 12.4 (6) 1.d, 2006).

Erosion Control

➢ Reduce, through designed management practices and appropriate erosion mitigation and revegetation/restoration measures, the project caused onsite erosion rates (calculated with appropriate USLE Methodology) by 75 percent within the first year after disturbance. (Forest Plan, Soil Resource Management KA1, 02, b.)

➢ Prohibit construction during wet and saturated periods as determined by the FS/BLM through inspection where construction of new facilities (roads, well pads, compressors etc.) occurs in floodplains or wetlands. Construction timing limitations would decrease the risk of facility site damage, water contamination, and stream and riparian impacts from flooding events. Retain stabilizing vegetation on unstable soils. Avoid new roads or heavy equipment use on unstable or highly erodible soils (FSH 2509.25 13.1 (9) 1.e, 2006).

➢ Avoid disturbance of unstable stream banks and headwall areas.

➢ Minimize erosion at sites located in steep terrain during the construction phase by measures such as contouring, water bars, temporary ditches, and detention basins, and minimize the period of disturbance.

➢ Use filter strips and sediment traps if needed to keep all sand-sized sediment on the land and disconnect disturbed soil from streams, lakes, and wetlands. Disperse runoff into filter strips (FSH 2509.25 13.2 (10) 1.b, 2006).

- Key sediment traps into the ground. Clean them out when 50 percent full. Remove sediment to a stable, gentle, upland site and revegetate (FSH 2509.25 13.2 (10) 1.c, 2006).
- Implement structural erosion and sediment controls such as interim or permanent water bars, detention ponds, straw bales, silt fences, earth dikes, and inlet and outlet protection. Provide non-structural erosion control practices such as interim and permanent and temporary seeding and revegetation, and geotextiles.
- Implement BMPs to slow or reduce the flow of surface-water runoff across disturbed areas, including diversion of surface runoff around facilities and installing erosion control devices to prevent sedimentation of nearby water bodies.
- During winter operations, maintain roads as needed to keep the road surface drained during thaws or breakups. Perform snow removal in such a manner that protects the road and adjacent resources. Do not use riparian areas, wetlands, or streams for snow storage or disposal. Remove snow berms where they result in accumulation or concentration of snowmelt runoff on the road or erodible fill slopes. Install snow berms where such placement will preclude concentration of snowmelt runoff and will serve to rapidly dissipate melt water (FSH 2509.25 13.3 (11) 1.j, 2006).
- Space cross drains according to road grade and soil type as indicated on Table 3-35. Do not divert water from one stream to another (FSH 2509.25 13.3 (11) 1.d, 2006).

Stormwater Management

- Prepare a Stormwater Management Plan for all construction sites that disturb five or more acres during the life of the project, or are part of a larger common plan of development. An authorized Construction General Permit must also be issued by CDPHE. Route surface runoff from well pads into reserve pits, if appropriate.

Contamination

- Plug and abandon non-productive wells and associated flowlines and equipment in a timely fashion to avoid leaks or breaks and subsequent spills.
- Require the companies prior to construction activities to develop and implement SPCC and emergency response plans to prevent, contain, and remediate spills. Workers should also be well trained considering these plans.
- Conduct routine inspections of facilities, pipelines, and well sites to evaluate whether there are spills or leaks and taking corrective actions, as appropriate.
- Use non-toxic, non-hazardous drilling fluids when practicable (FSH 2509.25 15.3 (17) 1.b, 2006).
- Spills shall be reported and appropriate clean-up action taken in accordance with applicable State and Federal laws, rules, and regulations. Contaminated soil and other material shall be removed from NFS lands and disposed of in a manner according to State and Federal laws, rules and regulations (FSH 2509.25 15.2 (16) 1.f, 2006).

Table 3-35 Maximum Cross-Drain Spacing

	Maximum Cross-Drain Spacing Based on Soil Types[1] (feet)			
Road Grade (percent)	ML, SM Extr. Erodible Silts-sands with little or no binder	MH, SC, CL Highly Erodible Silts-sands with moderate binder	SW, SP, GM, GC Mod. Erodible Gravels + fines & sands with little or no fines	GW, GP Low Erodible Gravels with little or no fines
1 – 3	600	1,000	1,000	1,000
4 – 6	300	540	680	1,000
7 – 9	200	360	450	670
10 – 12	150	270	340	510
13 – 15	120	220	270	410

Note:

1. These are maximum spacings. They should be reduced if warranted by onsite factors such as expected road use, downslope stability and erosion hazards, and filter strip capability to trap runoff and sediment and conserve ground cover integrity given the extra water. Combine these spacings with common sense to place cross drains where damage to ditches, slopes, and streams will be minimized. For example, shorten or extend the spacing where needed to move a cross-drain outlet from a stream headwall to a convex slope.

- Any pipeline construction in areas of known or potential landslide areas (See Chapter 3.4) shall require a design accepted by the BLM/FS prior to construction that minimizes to acceptable levels the risk that water from broken or leaking pipelines could activate landslides. Such a design could include leak detection systems or secondary containment systems (e.g., pipe-in-pipe).

The extent of road reconstruction and maintenance that would occur during development of the proposed road system would provide opportunities to correct many of the problems and risks associated with the current road system. The following mitigation measures to address road-related problems and risks are recommended as site-specific project mitigation:

- Drainage crossings in the Bull Creek area (along National Forest System Road [NFSR] 841) would be armored with rock or replaced with culverts of appropriate size to reduce sediment production from wet crossings.
- Areas of mass wasting on NFSR 743 would be stabilized by rip-rapping; installing French drains and careful geotechnical design; reshaping the fill slope to decrease water velocity and erosion; reseeding with aggressive, stabilizing plant species; applying geotechnical materials; using more advanced engineering; or other appropriate methods.
- The blocked egress from the culvert on NFSR 743 would be cleared of debris, so that it is functional.
- Gravel surfacing or other appropriate measures would be applied on NFSR 537 to reduce production of sediment.
- General maintenance would occur for all culverts along NFSR 537. Two culverts require specific attention. The ditches adjacent to these culverts would be cleaned out so that water will drain into the culverts properly.

Gullied roadbed and fill slope areas should be repaired to prevent additional gullying.

- The slump along NFSR 537 would be monitored for movement, particularly if this road is widened. If movement occurs, measures similar to those recommended for NFSR 743 should be used to stabilize this area.
- The blocked culvert along NFSR 613 would be cleaned out to allow proper drainage. Any damage to the roadbed or ditches should be repaired to prevent future erosion.
- The blocked culvert along NFSR 132 would be cleaned out to allow proper drainage. Any damage to the roadbed or ditches should be repaired to prevent future erosion.
- The west end of NFSR 132 would be relocated to a position higher on the slope and out of the highly erosive soils of the flat. The surface should be covered with gravel to reduce future erosion. Gully plugs, riprapping, or similar methods should be used in the existing gullies in the flat to prevent any further erosion and to increase sediment retention.

3.6.4.2 Monitoring

The SJNF LRMP states "Require concurrent monitoring to ensure that mitigation measures are effective and in compliance with State Water Quality Standards (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 10)."

Energy production companies would be required to implement a surface water quality monitoring program for the Project Area to evaluate the presence or absence of impacts associated with contamination of surface water from CBM. Monitoring of storm water controls by CBM development companies would be conducted at least once each year, at a minimum by late spring of each year. Reports of the BMP and SWCP implementation and effectiveness forms will be provided to the Forest Service and BLM by July 30 of each year.

- Fund a third party contractor approved by the agencies to monitor the trend and magnitude of dewatering effects at the Fruitland outcrop. This applies to the major rivers affected through gain-loss studies on the Pine, Piedra, and Florida Rivers. At the discretion of the Agencies, this could also apply to smaller streams identified by the affected public such as Squaw Creek, Bear Creek, Beaver Creek, Texas Creek, Stollsteimer Creek, and Fosset Gulch.
- Identify, inventory, and monitor areas where natural springs and seeps are present along the Pictured Cliff and Fruitland Formation outcrop. Continuous monitoring of a minimum of 5 spring/wetland/domestic well areas would be required to assess groundwater depletion impacts over the life of the project. See groundwater section for more details about this monitoring project.
- Review adequacy of BMPs and inspect the condition of water influence zones as construction-related activities are completed. This type of monitoring would occur annually over the entire drilling and completion phase. The CBM companies would be required to monitor BMP and mitigation implementation and effectiveness each year for a representa-

tive sample of activities occurring on federal lands during project build out. The monitoring would ideally be conducted during or just after wet weather periods such as monsoon season or spring melt-off. The monitoring reports would be provided to the agencies by July 1 of each year. The focus would be primarily on mitigation measures pertaining to storm water runoff prevention, road construction, well and pipeline construction and other ground disturbing activities.

- Photo point documentation of watershed conditions will be conducted on public lands within the Ignacio Creek, Bull Creek, Goose Creek, Little Squaw Creek, Zabel Canyon, Upper Spring Creek, and Salt Canyon watersheds. Photo points will be established prior to most new construction activities for each watershed. Photos will be taken 5 years after project commencement at a minimum. Photo points should be selected to record conditions where watershed impacts, such as gully development, slope instability, channel changes, etc. are predicted to occur.

3.6.5 Conformance with Existing Plans and Policies

3.6.5.1 FS Land Use Plans and Policies

LRMP direction, standards, and guidelines, are the mechanism by which the SJNF manages natural resources, demonstrating conformance with all applicable laws, policy, and direction. The LRMP for the SJNF (FS 1983) contains the following direction for managing surface water and riparian resources on National Forest lands.

3.6.5.1.1 Forest Direction (Water Quality)

Direction: Improve or maintain water quality to meet State water quality standards. However, where the natural background water pollutants cause degradation, it is not necessary to implement improvement actions. Short-term or temporary failure to meet some parameters of the State standard, such as increased sediment from road crossing construction or water resource development may be permitted in special cases (LRMP, III-47).

Standard: Colorado State Water Quality Standards (CDPHE 2002a).

Direction: Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03).

Direction: Rehabilitate disturbed areas that are contributing sediment directly to perennial streams as a result of management activities to maintain water quality and reestablish vegetation cover (LRMP, III–48).

Guideline: Reduce to natural rate any erosion due to management activity in the season of disturbance and sediment yields within one year of the activity through necessary mitigation measure such as water-barring and revegetation (LRMP, III–48).

Direction: Maintain sediment yield within threshold limits. The effects on water and sediment yields from vegetation manipulation and road construction projects will be determined through the use of appropriate modeling and/or quantification procedures to determine sediment yield threshold limits and water yield increase potentials (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 04).

Standard: Limit changes in channel rating or classification scores to an increase of 10 percent or less. Use channel stability criteria established by Cooper (1978) and Pfankuck (1975). Use channel classification criteria established by Rosgen (1980).

3.6.5.1.2 Management Area Direction (Riparian Areas – 9A)

Direction: Manage riparian areas to reach the latest seral stage possible within the stated objectives (LRMP, III-254).

Guideline a: Maintain all riparian ecosystems in at least an upper mid-seral successional stage based upon the R2 Riparian Ecosystem Rating System.

Direction: Proposed new land-use facilities (roads, campgrounds, buildings) will not normally be located within floodplain boundaries for the 100-year flood. Protect present and all necessary future facilities that cannot be located out of the 100-year floodplain by structural mitigation (deflection structures, riprap etc.) (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 02).

Standard: Implement mitigation measures when present or unavoidable future facilities are located in the active floodplain to ensure that State water quality standards, sediment yield thresholds, bank stability criteria, flood hazard reduction, and instream flow standards are met during and immediately after construction (Forest Plan – MA 9A GD, Standard and Guide 02).

Direction: Locate roads and trails outside riparian areas unless alternative routes have been reviewed and rejected as being more environmentally damaging (Forest Plan – MA 9A Transportation System Management – L01, L02, 01).

Guideline a: Do not parallel streams when road location must occur in riparian areas except where absolutely necessary. Cross streams at right angles. Locate crossings at points of low bank slope and firm surfaces (Forest Plan – MA 9A Transportation System Management – L01, L02, 01 S&G a.).

Guideline c: Maintain at least 80 percent of potential groundcover within 100 feet from the edges of all perennial streams, lakes and other waterbodies, or to the outer margin of the riparian ecosystem, where wider than 100 feet. (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 04 S&G c.).

Direction: Minimize detrimental disturbance to the riparian area by mineral activities. Initiate timely and effective rehabilitation of disturbed areas and restore riparian areas to a state of productivity comparable to that before disturbance (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01; LRMP Amendment, III-261).

Standard a: Prohibit the depositing of soil material from drilling, processing, or site preparation in natural drainageways (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G a.).

Standard b: Locate the lower edge of disturbed or deposited soil banks outside of the active floodplain (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G b.).

Standard c: Prohibit stockpiling of topsoil or any other disturbed soil in the active floodplain (LRMP Amendment, III-261).

Standard d: Discontinue heavy equipment use when soil compaction, rutting, and puddling are present (LRMP Amendment, III-261).

Standard e: Discontinue heavy equipment use when soil compaction, rutting, and puddling is present (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 01 S&G e.).

Direction: Locate mineral removal activities away from the waters edge or outside of the riparian area (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02).

Guideline a: Locate drilling mud pits outside of active floodplains unless alternate locations are more environmentally damaging. If location is unavoidable, seal and dike all pits to prevent leakage (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02 S&G a).

Guideline b: Drain and restore roads, pads, and drill sites immediately after use is discontinued. Revegetate to 80 percent of groundcover in the first year. Provide surface protection during storm-flow and snowmelt runoff events (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02 S&G b.).

Direction: Prevent soil surface compaction and disturbance in riparian ecosystems. Allow use of heavy construction equipment for construction, residue removal, etc. during periods when the soil is least susceptible to compaction or rutting (Forest Plan – MA 9A Soil Resource Management KA1 – GD, 02).

Guideline b: Reduce, through designed management practices and appropriate erosion mitigation and revegetation/restoration measures, the project caused on-site erosion rates (calculated with appropriate USLE Methodology) by 75 percent within the first year after disturbance. (Forest Plan , Soil Resource Management KA1, 02, b.)

Guideline c: Design continuing mitigation/restoration practices and follow-up maintenance activities to ensure that 80 percent original ground cover (vegetation) recovery occurs within five years after disturbance. (Forest Plan, Soil Resource Management KA1, 02, c.)

Direction: Maintain or enhance the long-term productivity of soils within the riparian ecosystem (Forest Plan – MA 9A Soil Resource Management KA1 – GD, 03).

Other Applicable Laws, Policy, and Direction

Federal actions taken by the SJNF are to comply with policy and direction given through the Region 2 Soil and Water Conservation Practices Handbook (FSH 2509.25). The Rocky Mountain Region of the FS developed the Watershed Conservation Practices Handbook to incorporate the legal and regulatory requirements for watershed management/protection contained in various laws, primarily the Organic Act, Multiple Use Sustained Yield Act, Endangered Species Act, National Forests Management Act, and Federal Land Policy Management Act, as well and the Clean Water Act. This handbook contains proven, effective watershed conservation practices to protect soil, aquatic, and riparian systems. Direction in this handbook applies to all actions on NFS lands. If used properly, the watershed conservation practices will meet applicable Federal and State laws and regulations, including State BMPs. During project implementation, Forests would apply applicable watershed conservation practices from this handbook, or acceptable alternatives, tailored to site-specific conditions. The Soil and Water Conservation Practices applicable to this project are listed in Section 3.6.4 Mitigation and Monitoring. The watershed conservation practices translate legal provisions and scientific principles into solid, common sense stewardship actions that support continued sustainable resource use.

3.6.5.1.3 Conformance with Forest Service Policy, Direction, and Standards

The watershed analysis suggests that several project alternatives may not conform to Direction and standards for the SJNF LRMP or to FS Region 2 Policy and Direction (FSH 2509.25). Each of these issue areas would be addressed through field siting, facility engineering, and utilization of BMPs and standards and guidelines applicable to watershed protection. The following discussion highlights areas where watershed compliance issues are anticipated. The detailed analyses of the watershed impacts associated with each area are presented in Sections 3.6.3.1 and 3.6.2.3.

A pipeline in Lange Canyon that is proposed in Alternative 1 would be constructed over extremely steep landslide terrain resulting in a high risk of failure. Pipeline failure can result in contamination due to spilled produced water and severe erosion could result. The amount of potential contamination and subsequent erosion would depend on the quantity of water spilled. An incident of this type may conflict with the following LRMP management standard: "Improve or maintain water quality to meet State water quality standards (LRMP, III–47)" as well as the following management standard: "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from ac-

tivities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03)."

New road and pipeline construction in Lange Canyon over steep, dissected landslide terrain, as proposed in Alternatives 1, 2, and 7, poses a high risk of pipeline failure which can result in substantive negative watershed impacts. Similarly, road and pipeline construction considered in Alternatives 1 and 2, over landslide terrain on a steep divide between Lange Canyon headwaters and the Lower Piedra watershed poses a high risk of pipeline failure and/or significant negative watershed impacts. Third, Alternatives 1 and 2 propose facility construction that would result in significant floodplain modification and water quality impacts in Crowbar Creek and Armstrong Canyon. These three actions may conflict with the following management standard: "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03) and "Improve or maintain water quality to meet State water quality standards. (LRMP, III–47)."

Two wells in Zabel Canyon and their associated roads and pipelines proposed in Alternatives 1, 2, 6, and 7 are predicted to have a high risk of substantive negative watershed impacts. Roads, pipelines, and well pads located on the ridgeline divide between Spring Creek, Salt Creek, and Ignacio Creek on landslide terrain and steep, erosive, and dissected ridgelines are also predicted to have a high risk of substantive negative impacts. Facility construction in these areas may not comply with the following management standards: "Improve or maintain water quality to meet State water quality standards. (LRMP, III–47); and "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03)."

Under Alternatives 1 and 2, the development of roads, pipelines and wells in the highly unstable, landslide-prone, and erosive Ignacio Creek watershed are predicted to have substantive negative watershed impacts. Substantive negative water quality impacts are also predicted to a result of pipeline construction in the steep, unstable headwaters of Little Squaw Creek under Alternative 2 and with road, well and pipeline locations along Little Squaw Creek under Alternatives 1, 2, and 7. These activities may not comply with the following management standards: "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03) and "Improve or maintain water quality to meet State water quality standards. (LRMP, III–47)."

In the Goose Creek watershed, extensive proposed road, well, and pipeline construction parallel to the stream and inside the WIZ are predicted to substantively impact the stream. Within the largely undeveloped Bull Creek watershed, Alternatives 1, 2, 5, 6, and 7 propose extensive new road, well, and pipeline construction parallel to the stream and in the WIZ and through narrow, confined canyon bottoms. These activities may not comply with the following management standards: "Locate mineral removal activities away from the waters edge or outside of the riparian area (Forest Plan – MA 9A Mining Law Compliance and Admini-

stration – GD, 02)" and "Do not encroach fills or introduce soil into streams, swales, lakes or wetlands (WCP *10–1230* 2005)," and: "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03)," and: "Locate roads and trails outside riparian areas unless alternative routes have been reviewed and rejected as being more environmentally damaging (Forest Plan – MA 9A Transportation System Management – L01, L02, 01).

Alternatives 1, 2, 6, and 7 all propose multiple compressor stations (up to three compressor stations in Alternatives 1, 2, and 7) that would be located in the WIZ of Fosset Gulch Creek. Construction of these facilities may not comply with the following management standards: "Proposed new land-use facilities (roads, campgrounds, buildings) will not normally be located within floodplain boundaries for the 100-year flood. (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 02)" and "Locate mineral removal activities away from the waters edge or outside of the riparian area (Forest Plan – MA 9A Mining Law Compliance and Administration – GD, 02)" and "Locate new concentrated use sites outside the WIZ, if practicable and outside riparian areas and wetlands always. Armor or reclaim existing sites in the WIZ to prevent detrimental soil and bank erosion (WCP *10-240* 2005)."

Also in Fosset Gulch, Alternative 2 proposes substantive new facility construction within the WIZ, over steep, erosive soils resulting in potential floodplain and riparian impacts. This construction may not be in compliance with the following management standard: "Prevent stream channel instability, loss of channel cross-sectional areas, and loss of water quality resulting from activities that alter vegetative cover (Forest Plan – MA 9A Water Resource Improvement and Maintenance – GD, 03)".

Road locations adjacent to Pole Creek under all alternatives may be moved to a location outside of the WIZ on a gentle adjacent upland site – field siting would determine whether this is feasible. This alternate location would greatly reduce impacts to Pole Creek. The current location may not comply with the management standard: "Locate roads and trails outside riparian areas unless alternative routes have been reviewed and rejected as being more environmentally damaging (Forest Plan – MA 9A Transportation System Management – L01, L02, 01)."

3.6.5.2 Conformance with BLM Land Use Plans and Policies

The RMP for the San Juan/San Miguel Resource Areas (BLM 1985) established general management objectives and guidelines for water resources to maintain surface water quality and preserve existing water uses. Water resources are evaluated on a case-by-case basis at the project level planning stage. Stipulations for surface water resource management are attached to each project plan as appropriate, and BMPs listed in the RMP appendix are recommended.

Additionally, in 1991 the BLM Director approved the *Riparian-Wetland Initiative for the 1990s*, which establishes national goals and objectives for managing riparian-wetland resources on public lands. One of the chief goals of this initia-

tive is to restore and maintain riparian-wetland areas so that 75 percent or more are in proper functioning condition (PFC) by 1997. The overall objective of this goal is to achieve advanced ecological status, except where resource management objectives, including PFC, would require an earlier successional stage, thus providing the widest variety of vegetation and habitat diversity for wildlife, fish, and watershed projection (Prichard et al. 1993).

Authorization of the Proposed Action would require full compliance with RMP management directives that relate to maintaining or improving surface water quality and quantity. With the implementation of the mitigation measures following each described Stipulation Code, all action alternatives are in conformance with the RMP for the San Juan/San Miguel Resource Areas (BLM 1985) and the ROD for Oil and Gas Plan Amendment to the San Juan/San Miguel RMP (BLM 1991):

- Stipulation Code CO–28 states, "For the protection of perennial water impoundment and streams, and/or riparian /wetland vegetation zones, activities associated with oil and gas exploration and development including roads, transmission lines, storage facilities, are restricted to an area beyond the riparian vegetation zone." This stipulation may be excepted subject to an onsite impact analysis with consideration given to degree of slope, soils, importance to the amount and type of wildlife and fish use, water quality, and other related values.
- Stipulation Code CO–27 specifies prior to surface disturbance on slopes of, or greater than, 40 percent, an engineering/reclamation plan must be approved by the Authorized Officer. Such plans must demonstrate how the following will be accomplished:
  a. Site productivity will be restored.
  b. Surface runoff will be adequately controlled.
  c. Off-site areas will be protected from accelerated erosion such as drilling, gullying, piping, and mass wasting.
  d. Surface-disturbing activities will not be conducted during extended wet periods.
  e. Construction will not be allowed when soils are frozen.

All action alternatives are in compliance with the RMP and the ROD. Additionally, on BLM Lands all action alternatives will meet the objectives and goals of the BLM *Riparian-Wetland Initiative for the 1990s*.

3.6.5.3 Wild and Scenic Rivers

There are no recommended or designated Wild and Scenic Rivers within the project area. Currently, a comprehensive Wild and Scenic Rivers analysis is being conducted for the entire San Juan Public Lands. This analysis should be completed by the end of the year 2006. The preliminary Wild and Scenic eligibility list for the San Juan Public Lands does not include any rivers within the project area. Because no potentially eligible, suitable, recommended, or designated rivers currently exist in the analysis area, the project would have no impact on Wild and Scenic Rivers and is in conformance with BLM and FS agency direction and policy.

3.6.5.4 Executive Order 11990 — Protection of Wetlands and Executive Order 11988 — Floodplain Management

The Protection of Wetlands order requires Federal agencies to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Analysis is required to determine whether adverse impacts to wetlands would result.

The Protection of Floodplains order requires Federal agencies to provide leadership and to take action to (1) minimize adverse impacts associated with occupancy and modification of floodplains and reduce risks of flood loss, (2) minimize the impacts of floods on human safety, health, and welfare, and (3) restore and preserve the natural and beneficial values served by floodplains.

Alternatives 1 through 7 include facility locations planned in floodplains and wetlands on NFS lands covered by Executive Order (E.O.) 11988 and E.O. 11990. Consistent with Forest Plan direction and executive orders, floodplain impacts will be avoided by moving proposed activities out of floodplain areas where possible when NOSs, APDs and ROW applications are received. To date, 56 well locations and associated roads and pipeline routes have been field sited. Of these, 47 have been located outside of floodplains and nine have potential floodplain impacts. This latter category requires additional fieldwork to determine actual floodplain boundaries and potential impacts.

For all APDs received in the Project Area, conformance with E.O. 11988 (Floodplain Management) and E.O. 11990 (Protection of Wetlands) will be determined by following the eight-step process outlined in Forest Service Manual Amendment No. 2500–2000–2 for Watershed and Air Management. In accordance with this process, the public will be provided with a finding and explanation of any final decision if there is no practicable alternative to locating project activities in a floodplain.

The eight-step process is:

1. Determine whether the proposed action is located in the base floodplain (500-year floodplain for critical actions); or whether it has the potential to affect a floodplain or indirectly support floodplain development. If not, or if an action is of an emergency nature (Forest Service Manual [FSM] 2527.06b), requirements of the E.O. will have been satisfied.
2. Notify the public at the earliest possible time of any plan or proposal to undertake, support, or allow an action which would result in the occupancy, modification, or development in a floodplain, and involve the affected and interested public in the decision-making process.
3. Identify and evaluate practicable alternatives to locating a proposed action in a floodplain, including alternative sites outside the floodplain, alternative actions serving the same purpose as the proposed action, and the “no action” option.
4. Identify the full range of potential direct or indirect adverse impacts associated with the occupancy or modification of the floodplain and the po-

tential direct and indirect support of floodplain development that could result from the proposed action.

5. Identify and evaluate mitigating measures that will minimize the potential adverse impacts of the action if avoidance cannot be achieved, and measures that will preserve and restore or enhance the natural and beneficial floodplain values that would be adversely impacted by the action.
6. Reevaluate the proposed action to determine first, if it is still practical, even with the application of appropriate mitigating measures and in light of its exposure to flood hazards and its potential to adversely affect the floodplain and, second, if the alternatives identified in step 3 are practicable in light of information gained in the preceding steps 4 and 5.
7. Prepare and provide the public with a finding and public explanation of any final decision that there is no practicable alternative to locating an action in, or adversely affecting, a floodplain.
8. Provide ongoing review of implementation and post-implementation phases of the proposed action to ensure that all provisions associated with the action, including appropriate mitigating measures as identified in the environmental assessment, are fully implemented.

3.6.6 Unavoidable Adverse Effects

Unavoidable adverse effects on surface water resources would occur under each of the five alternatives in localized areas. Erosion and sedimentation of surface water drainages would occur during construction when well pads and access roads are cleared of vegetation, and before reclamation, when vegetation has not been reestablished. At peak CBM development, the associated ground-water withdrawals will intercept a maximum of about 200 acre-feet per year of Fruitland Formation groundwater that would normally discharge into the Animas, Florida, Pine, and Piedra Rivers (Questa 2000, Cox et al. 2001). There may be additional impacts to existing water rights on some streams when calls cannot be satisfied by existing instream flows.

3.6.7 Irreversible and Irretrievable Effects

An irreversible or irretrievable commitment of resources would occur when resources would be consumed, committed, or lost as a result of the project. The commitment of resources would be irreversible if the project started a process (chemical, biological, or physical) that could not be stopped. As a result, the resource or its productivity or its utility would be consumed, committed, or lost forever. Commitment of a resource would be considered irretrievable when the project would directly eliminate the resource, its productivity, or its utility for the life of the project and possibly beyond.

The commitment of surface waters would be irretrievable when the project directly eliminates the water source, such as when surface water supplies are used for well drilling and completion.

3.7 Soils

3.7.1 Issues

Issue 15: The effects of the additional CBM development on soils in and down-stream of the project area.

- To what degree does road and well pad construction contribute to soil erosion?
- What is the potential for contaminant spills and how would they affect soils? (Addressed in Health and Safety)
- Will CBM development contribute to loss of topsoil and how would that, in turn, affect agriculture, forestry, and wildlife habitat?

3.7.2 Affected Environment

3.7.2.1 Regional Characterization

Soils within the Project Area have developed in residuum, colluvium, alluvium, and, to a lesser extent, in eolian materials derived from interbedded sandstones and shales in the lower areas. They also have developed from igneous and metamorphic materials in the higher, more mountainous areas (Bauer et al. 1981). Surface textures range from clay loams to sandy loams with varying amounts of gravel or coarser materials. Slopes range from nearly level to very steep, with deeper soils found in the less steeply sloping areas.

Two soil surveys have been completed throughout the Project Area: the La Plata County survey in the west and the Piedra Area survey in the east. Soils series from the two surveys with matching names or similar characteristics were merged into one map unit for continuity. Figure 3–30 shows the distribution of the 55 soil map units that resulted from this merge. Each map unit is named for the dominant soil types. Summaries of the areal extent of all map units in the Project Area, the dominant soils series for all associations in the Project Area, and the general characteristics of the soils are shown on Table 3-36 and Table 3-37.

The areal extent of each map unit in the Project Area is listed on Table 3-36, along with the dominant soil series for all the associations in the Project Area and the general characteristics of the soil. Table 3-38 lists the severity of hazards based on these characteristics. Series with severe wind and water erosion hazards, high potential for compaction, high salinity, poor potential for revegetation, and prime or otherwise valuable agricultural soils are identified in the table.

Table 3-36 Areal Extent of Soils in the Project Areas

Map Unit	Soil Series	Surface Texture	Area (Acres)	Percent Coverage
La Plata Soil Survey				
2	Alamosa	Loam	428	0.3
5	Arboles	Clay	6,285	5.0
7	Archuleta Sanchez	Loam Very Stony Sandy Clay Loam	14,860	11.8
9[1]	Badland	Shale	1,124	0.9
10	Bayfield	Silty Clay Loam	178	0.1
12	Bayfield	Silty Clay Loam, Seeped	350	0.3
13	Big Blue	Clay Loam	431	0.3
14	Bodot	Clay	1,666	1.3
22	Corta	Loam	863	0.7
23[2]	Corta	Loam	7,332	5.8
25	Durango	Cobbly Loam	236	0.2
26	Falfa	Clay Loam	875	0.7
27	Falfa	Clay Loam	4,644	3.7
28	Fluvaquents	Gravelly Cobbly Sandy Loam	910	0.7
29	Fortwingate	Stony Fine Sandy Loam	68	0.1
30	Fortwingate Rock Outcrop	Stony Fine Sandy Loam Rock	1,321	1.1
32	Haploborolls Rubble Land	Stony Sandy Loam Rock Fragments	94	0.1
34	Harlan	Cobbly Loam	9	0.01
37	Herm	Loam	3,434	2.7
39	Hesperus	Loam	3,139	2.5
42	Lazear Rock Outcrop	Stony Loam Rock	625	0.5
44	Mikim	Loam	124	0.1
45	Nebar	Stony Sandy Loam	7	0.01
50[3]	Pescar	Fine Sandy Loam	919	0.7
53	Pinata	Loam	111	0.1
58	Rock Outcrop	Rock	790	0.6
59	Sedillo	Gravelly Sandy Loam	426	0.3
60	Shalona	Loam	21	0.02
62	Sili	Loam	117	0.1
63	Sili	Loam	69	0.1
64	Simpactico	Loam	388	0.31
65	Sycle	Fine Sandy Loam	104	0.1
66	Tefton	Loam	433	0.3
70[4]	Ustic Torriorthents Ustollic Haplargids	Gravelly Sandy Loam Gravelly sandy loam	2,622	2.1
74	Vosburg	Fine Sandy Loam	374	0.3
76	Witt	Loam	9	0.01
81	Zyme	Clay Loam	3,257	2.6
82	Rock Outcrop	Rock	9,169	7.3
Piedra Soil Survey				
4D	Carracas	Loam	3,830	3.1
4E	Carracas	Loam	21,405	17.1
8E	Chris	Gravelly Loam	1,531	1.21
11E	Corta	Silt Loam	13,889	11.1
12D	Dunton	Loam	1,113	0.9
13D	Dunton	Stony Loam	97	0.1

Table 3-36 Areal Extent of Soils in the Project Areas

Map Unit	Soil Series	Surface Texture	Area (Acres)	Percent Coverage
16D	Greenough	Loam	233	0.2
19D	Helfin	Sandy Loam	1,708	1.4
22A	Hunchback	Clay Loam	141	0.1
22D	Hunchback	Clay Loam	789	0.6
30E	Mayoworth .	Silt Loam	1,361	1.1
36A	Nunn	Loam	6,432	5.1
36D	Nunn	Loam	4,762	3.8
39A	Riverwash	Rock, Gravel, Stone	110	0.1
84	Open Water		127	0.1

Notes:
1. The 3 Badland, from the Piedra Survey, was merged with 9 Badland from the La Plata Survey.
2. The 11D Corta Silt Loam, from the Piedra Survey, was merged with 23 Corta Loam from the La Plata Survey.
3. The 38A Pescar Sandy Loam, from the Piedra Survey, was merged with 50 Pescar Fine Sandy Loam from the La Plata Survey.
4. The 43 Sandstone Outcrop-Ustorthents Complex, from the Piedra Survey, was merged with 70 Ustic Torriorthents-Ustollic Haplargids Complex from the La Plata Survey.

Table 3-37 Characteristics of Soil Map Units

Map Unit	Soil Series	Surface Texture	Physiographic Location	Parent Material	Slopes (%)	Depth Class	Drainage class	Available Water Capacity	Clay Content	Permeability	Salinity	K-Factor	T-Factor	Wind Erodibility	Land Capability Non-Irr	Land Capability Irr
La Plata County Soil Survey																
2	Alamosa	Loam	Alluvial valley floors, fans, and bottoms	Alluvium	0-2	Deep	Poor	High	15-35	0.2-0.6	<2	0.26	5	6	Vw	IIIw
5	Arboles	Clay	Side slopes, upland valleys	Alluvium from shale (sh)	3-12	Deep	Well	High	35-55	0.06-0.2	<2	0.37	5	4	IV e	IV e
7	Archuleta	Loam	Hills, ridges, mountainsides	Residuum from interbedded sandstone (ss) and sh	12-65	Shallow	Well	Low	18-35	0.6-0.2	<2	0.24	1	6	VII e	---
	Sanchez	Very Stony Sandy Clay Loam				Shallow	Well	Very Low	20-35	0.2-0.6	<2	0.10	1	6		
9[1]	Badland	Shale	Steep and very steep	Mancos sh	---	---	---	---	---	---	---	---	---	---	VIII e	---
10	Bayfield	Silty Clay Loam	Broad valleys	Alluvium from sh	1-3	Deep	Well	High	30-50	0.06-0.2	<4	0.24	5	5	VI e	III e
12	Bayfield	Silty Clay Loam, Seeped	Broad valleys	Alluvium from sh	1-3	Deep	Poor	High	30-50	0.06-0.2	<4	0.24	5	5	VI w	IV w
13	Big Blue	Clay Loam	Low terraces, valley bottoms, alluvial valley floors	Alluvium from sh	0-6	Deep	Poor	High	27-50	0.06-0.2	<2	0.24	5	5	V w	V w
14	Bodot	Clay	Hills	Residuum from sh	3-10	Moderately Deep	Well	Low	35-50	0.06-0.2	2-8	0.32	2	4	IV e	IV e
22	Corta	Loam	Mesa tops, ridgetops, old pediment surfaces	Alluvium from sh mixed with loess	1-3	Deep	Well	High	20-50	<0.06	<2	0.37	4	5	III c	III e
23[2]	Corta	Loam	Mesa tops, ridgetops, old pediment surfaces	Alluvium from sh mixed with loess	3-8	Deep	Well	High	20-50	<0.06	<2	0.37	4	5	IV e	IV e
25	Durango	Cobbly Loam	Mesa tops, ridgetops dissected by drainages	Glacial outwash	3-20	Deep	Well	High	10-50	.2-2.0	<2	0.32	5	8	VII s	---
26	Falfa	Clay Loam	Mesa tops	Calcerous loess	1-3	Deep	Well	High	28-50	.06-.6	<2	0.28-0.32	5	4	III c	III e
27	Falfa	Clay Loam	Mesa tops	Calcerous loess	3-8	Deep	Well	High	28-50	.06-.6	<2	0.28-0.32	5	4	IV e	IV e
28	Fluvaquents	Gravelly Cobbly Sandy Loam	Recent alluvial valley floors	Alluvial deposits	0	Deep	Somewhat poorly	Very Low	0-10	2.0-6.0	<2	0.10	5	2	VII w	---
29	Fortwingate	Stony Fine Sandy Loam	Mountainsides	Ss mixed with loess	3-12	Deep	Well	Low	8-45	0.2-6.0	<2	0.15-0.28	2	4	VI e	---
30	Fortwingate	Stony Fine Sandy Loam	Mountainsides	Ss mixed with loess	6-25	Deep	Well	Moderate	8-45	0.2-6.0	<2	0.15-0.28	2	4	VII s	---

Table 3-37 Characteristics of Soil Map Units

Map Unit	Soil Series	Surface Texture	Physiographic Location	Parent Material	Slopes (%)	Depth Class	Drainage class	Available Water Capacity	Clay Content	Permeability	Salinity	K-Factor	T-Factor	Wind Erodibility	Land Capability	
	Rock Outcrop	Rock		Sandstone	---	---	---	---	---	---	---	---	---	---	VIII e	---
32	Haploborolls	Stony Sandy Loam	Mountainsides	---	10-60	Moderately Deep	Well	Moderate	18-35	0.2-2.0	<2	0.10	5	8	VII e	---
	Rubble Land	Rock Fragments		Surrounding rock		---	---	---	---	---	---	---	---	---	VIII e	---
34	Harlan	Cobbly Loam	Terraces along drainages on mesas	Cobbly alluvium, glacial outwash	3-15	Deep	Well	Moderate	10-35	0.6-6.0	<2	0.10-0.24	5	8	VI e	---
37	Herm	Loam	Mountainside, valley floors	Alluvium from sh	6-25	Deep	Well	High	15-50	0.06-2.0	<2	0.24	5	5	VI e	---
39	Hesperus	Loam	Alluvial fans, valley bottoms	Alluvium	3-12	Deep	Well	High	10-35	0.6-20.0	<2	0.28-0.32	5	5	IV e	IV e
42	Lazear	Stony Loam	Edge of mesas and breaks	Residual material from ss and sh	12-65	Shallow	Well	Very Low	15-32	0.6-2.0	<2	0.17-0.20	1	8	VII s	---
	Rock Outcrop	Rock		Sandstone		---	---	---	---	---	---	---	---	---	VIII e	---
44	Mikim	Loam	Alluvial fans, foothill valleys	Alluvium	3-12	Deep	Well	High	10-32	0.6-2.0	<2	0.32	5	5	IV e	IV e
45	Nebar	Stony Sandy Loam	Terraces along major drainageways	Glacial outwash or till	1-6	Deep	Well	Low	10-50	0.2-6.0	<2	0.05-0.15	2	8	VI e	---
50[3]	Pescar	Fine Sandy Loam	Flood plains, low terraces, alluvial valley floors	Stratified calcareous alluvium	0-2	Deep	Somewhat poorly	Low	8-18	2.0-20.0	<2	0.05-0.24	5	3	IV w	IV w
53	Pinata	Loam	Mountainsides	Glacial outwash, till mixed with eolian sediment	12-40	Deep	Well	Moderate	10-60	0.06-2.0	<2	0.15-0.32	3	5	VII e	---
58	Rock Outcrop	Rock	Cliffs, breaks, ridges, mountainsides	Sandstone, limestone, quartzite, granite, shist	---	---	---	---	---	---	---	---	---	---	VIII e	---
59	Sedillo	Gravelly Sandy Loam	Old, high terraces of major river valleys	Cobbly glacial outwash	0-3	Deep	Well	Moderate	18-35	0.2-2.0	<2	0.10-0.20	3	9	Vi s	---
60	Shalona	Loam	Old, high terraces	Mixed alluvium from ss and sh	1-6	Deep	Well	High	10-35	0.2-6.0	<2	0.24	5	4	III e	III e
62	Sili	Loam	Upland valley bottoms, fans	Alluvium from sh	1-3	Deep	Well	High	27-50	0.2-0.6	<2	0.37	5	4L	IV c	III e
63	Sili	Loam	Upland valley bottoms, fans	Alluvium from sh	3-6	Deep	Well	High	27-50	0.2-0.6	<2	0.37	5	4L	IV e	III e
64	Simpactico	Loam	In drainageways on mesa tops	Alluvium from loess	1-3	Deep	Well	High	10-35	0.2-2.0	<2	0.28-0.32	4	5	III c	III e

Table 3-37 Characteristics of Soil Map Units

Map Unit	Soil Series	Surface Texture	Physiographic Location	Parent Material	Slopes (%)	Depth Class	Drainage class	Available Water Capacity	Clay Content	Permeability	Salinity	K-Factor	T-Factor	Wind Erodibility	Land Capability	
65	Sycle	Fine Sandy Loam	Terraces on major drainageways	Alluvium overlying river-deposited cobbles and gravel	1-3	Deep	Well	Low	0-35	0.6-20.0	<2	0.02-0.28	3	6	III c	III e
66	Tefton	Loam	Flood plains, alluvial valley floors	Mixed alluvium	1-3	Deep	Poor	High	0-35	0.2-20.0	<2	0.02-0.37	5	8	III w	III w
70[4]	Ustic Torriorthents	Gravelly Sandy Loam	Terrace and mesa edges, hillsides	Outwash	12-60	Deep	Well	Low	5-25	0.6-2.0	<2	0.05	5	8	VII e	---
	Ustollic Haplargids	gravelly sandy loam		Gravelly, cobbly alluvium		Deep	Well	Low	5-30	0.6-6.0	<2	0.17-0.20	5	6	---	---
74	Vosburg	Fine Sandy Loam	Swales, foot slopes of uplands	Alluvium from ss and sh	3-8	Deep	Well	High	8-35	0.6-6.0	<2	0.20-0.24	3	3	IV e	IV e
76	Witt	Loam	Uplands and mesas	Calcareous loess	3-8	Deep	Well	High	10-30	0.2-2.0	<2	0.37-0.43	5	5	IV e	IV e
81	Zyme	Clay Loam	Ridges, hills	Residuum from loess	3-25	Deep	Well	Low	35-45	0.06-0.6	<2	0.43	1	4	VI e	---
82	Zyme	Clay Loam	Ridges, hills	Residual from sh	12-65	Shallow	Well	Low	35-45	0.06-0.6	<2	0.43	1	4	VII e	---
	Rock Outcrop	Rock		Shale		---	---	---	---	---	---	---	---	---	VIII e	---
Piedra Area Soil Survey																
4D	Carracas	Loam	Ridge tops, mesas	Residuum of interbedded ss and sh	4-25	Shallow	Low	Low	NA	0.6-2.0	---	0.20	1	5	VI e	
4E	Carracas	Loam	Valley, canyon sides, scarp slopes	Residuum and alluvium of ss	25-65	Shallow	Low	Low	NA	0.6-2.0	---	0.20	1	5	VII e	
8E	Chris	Gravelly Loam	Mesas	Residuum of interbedded ss and sh	25-65	Deep	Moderate	Low	NA	0.06-2.0	<2	0.1-0.24	3	5	VI e	
11E	Corta	Silt Loam	Canyon/Sides	Residuum and alluvium of ss	25-65	Deep	Well	Moderate	NA	<0.06-0.6	<2	0.28-0.37	3	5	VII e	
12D	Dunton	Loam	Mesa and cuesta dip-slopes	Residuum of ss	4-25	Moderately Deep	Well	Moderate	NA	0.06-2.0	---	0.24-0.32	2	5	VI e	
13D	Dunton	Stony Loam	Mesa and cuesta dip-slopes	Residuum of ss	4-25	Moderately Deep	Well	Moderate	NA	0.06-2.0	---	0.24-0.32	2	5	VI s	
16D	Greenough	Loam	Low, rolling hills	Loess over ss and sh	4-25	Deep	Well	High	NA	0.6-2.0	---	0.37	3	5	VI e	
19D	Helfin	Sandy Loam	Valley toe slopes	Alluvium of mostly ss and some sh	4-25	Deep	Well	High	NA	0.2-2.0	---	0.32	3	3	VI e	

Table 3-37 Characteristics of Soil Map Units

Map Unit	Soil Series	Surface Texture	Physiographic Location	Parent Material	Slopes (%)	Depth Class	Drainage class	Available Water Capacity	Clay Content	Permeability	Salinity	K-Factor	T-Factor	Wind Erodibility	Land Capability
22A	Hunchback	Clay Loam	Swales, basins, concave drainageways	Alluvium and colluvium of mixed origin	0-4	Deep	Somewhat poorly	High	NA	0.06-0.2	<2	0.32	5	6	VI w
22D	Hunchback	Clay Loam	Fans and toe-slopes	Alluvium and colluvium of mixed origin	4-15	Deep	Somewhat poorly	High	NA	0.06-0.2	<2	0.32	5	6	VI e
30E	Mayoworth	Silt Loam	Mesas, scarp slopes, valley sides	Residuum of sh and sandy sh	25-65	Moderately Deep	Well	Moderate	NA	0.06-2.0	<2	0.37-0.43	2	5	VII e
36A	Nunn	Loam	Alluvial plains and piedmonts	Alluvium of sh and some ss	0-4	Deep	Well	Moderate	NA	0.06-2.0	<2	0.24-0.28	5	5	III e
36D	Nunn	Loam	Alluvial plains and piedmonts	Alluvium of sh and some ss	4-25	Deep	Well	Moderate	NA	0.06-2.0	<2	0.24-0.28	5	5	IV e
39A	Riverwash	Rock Gravel Stone	---	---	---	---	---	---	---	---	---	---	---	---	VIII w

Notes:
1 The 3 Badland, from the Piedra Survey, was merged with 9 Badland from the La Plata Survey.
2 The 11D Corta Silt Loam, from the Piedra Survey, was merged with 23 Corta Loam from the La Plata Survey.
3 The 38A Pescar Sandy Loam, from the Piedra Survey, was merged with 50 Pescar Fine Sandy Loam from the La Plata Survey.
4 The 43 Sandstone Outcrop-Ustorthents Complex, from the Piedra Survey, was merged with 70 Ustic Torriorthents-Ustollic Haplargids Complex from the La Plata Survey.
Rock Outcrop, Rubble Land, and Riverwash consist almost entirely of hard rock and will not be characterized as soils for this analysis

Table 3-38 Severity of Hazards for Soils in Project Area

Map Unit	Soil Series	Salinity	Shrink/Swell	Water Erosion Hazard	Wind Erosion Hazard	Prime Agriculture Soils	Revegetation Potential
La Plata County Soil Survey							
2	Alamosa	Low	Moderate	Low	Low	No	Moderate
5	Arboles	Low	High	Moderate	Moderate	No	Moderate
7	Archuleta Sanchez	Low	Moderate	Moderate	Low	No	Low
9[1]	Badland	Low	Low	High	High	No	Low
10	Bayfield	Low	High	High	Low	Yes	Moderate
12	Bayfield	Low	High	Low	Low	No	Moderate
13	Big Blue	Low	High	Low	Low	No	Moderate
14	Bodot	Low-Moderate	High	High	Moderate	No	Moderate
22	Corta	Low	High	Moderate	Low	Yes	High
23[2]	Corta	Low	High	Moderate	Low	Yes	Moderate
25	Durango	Low	Moderate-High	Low	None	No	Low
26	Falfa	Low	Moderate-High	Moderate	Moderate	Yes	High
27	Falfa	Low	Moderate-High	Moderate	Moderate	No	Moderate
28	Fluvaquents	Low	Low	Low	High	No	Low
29	Fortwingate	Low	Moderate-High	Low	Moderate	No	Moderate
30	Fortwingate Rock Outcrop	Low	Moderate-High	Low	Moderate	No	Low
32	Haploborolls	Low	Low	Moderate	None	No	Low
	Rubble Land	Low	Low	Low-High	Low-High	No	Low
34	Harlan	Low	Low-Moderate	Moderate	None	No	Moderate
37	Herm	Low	Low-High	Low	Low	No	Moderate
39	Hesperus	Low	Low	Low	Low	Yes	Moderate
42	Lazear Rock Outcrop	Low	Low	Moderate	None	No	Low
44	Mikim		Low	High	Low	No	Moderate
45	Nebar	Low	Low-Moderate	Low	None	No	Moderate
50[3]	Pescar	Low	Low	Low	Low-Moderate	No	Moderate
53	Pinata	Low	Low-High	Moderate	Low	No	Low
58	Rock Outcrop						
59	Sedillo	Low	Low	Low	None	No	Moderate
60	Shalona	Low	Low-Moderate	Low	Moderate	Yes	High
62	Sili	Low	Moderate-High	Moderate	Moderate	Yes	Moderate
63	Sili	Low	Moderate-High	Moderate	Moderate	Yes	Moderate
64	Simpactico	Low	Low-Moderate	Low	Low	Yes	High
65	Sycle	Low	Low-Moderate	Low	Low	Yes	High
66	Tefton	Low	Low	Moderate	None	No	High
70[4]	Ustic Torriorthents Ustollic Haplargids	Low	Low	High	Moderate High	No	Low
74	Vosburg	Low	Low	Moderate	Moderate	No	Moderate
76	Witt	Low	Low-Moderate	Moderate	Low	No	Moderate
81	Zyme	Low	High	High	Moderate	No	Moderate
82	Zyme Rock Outcrop	Low	High	High	Moderate High	No	Low
Piedra Area Soil Survey							
4D	Carracas	Low	Low	Moderate	Low	No	Moderate
4E	Carracas	Low	Low	High	Low	No	Low
8E	Chris	Low	Low-Moderate	Moderate	Low	No	Moderate
11E	Corta	Low	Low-High	High	Low	No	Low
12D	Dunton	Low	Low-High	Moderate	Low	No	Moderate

Table 3-38 Severity of Hazards for Soils in Project Area

Map Unit	Soil Series	Salinity	Shrink/Swell	Water Erosion Hazard	Wind Erosion Hazard	Prime Agriculture Soils	Revegetation Potential
13D	Dunton	Low	Low-High	Moderate	Low	No	Moderate
16D	Greenough	Low	Low-Moderate	Moderate	Low	No	Moderate
19D	Helfin	Low	Low-High	Moderate	Moderate	No	Moderate
22A	Hunchback	Low	High	Low	Low	No	Moderate
22D	Hunchback	Low	High	Low-Moderate	Low	No	Moderate
30E	Mayoworth	Low	Low-High	High	Low	No	Low
36A	Nunn	Low	Moderate-High	Moderate	Low	No	High
36D	Nunn	Low	Moderate-High	Moderate	Low	No	Moderate
39A	Riverwash	Low	Low	Low-High	Low-High	No	Low

Notes:
1. The 3 Badland, from the Piedra Survey, was merged with 9 Badland from the La Plata Survey.
2. The 11D Corta Silt Loam, from the Piedra Survey, was merged with 23 Corta Loam from the La Plata Survey.
3. The 38A Pescar Sandy Loam, from the Piedra Survey, was merged with 50 Pescar Fine Sandy Loam from the La Plata Survey.
4. The 43 Sandstone Outcrop-Ustorthents Complex, from the Piedra Survey, was merged with 70 Ustic Torriorthents-Ustollic Haplargids Complex from the La Plata Survey.

3.7.2.2 CBM Development and Soil Erosion

3.7.2.2.1 Concerns

Clearing vegetation and excavating, compacting, stockpiling, and redistributing soils during construction and reclamation all affect soils. Removal of vegetation exposes soils, making them vulnerable to wind and water erosion. Excavation for facility pads and roads can increase the grade of slopes in cut and fill areas, exposing and loosening soils. Removal and stockpiling of soils for reclamation can mix soil profiles and alter the erosive characteristics. Compaction of the soil can decrease permeability and increase runoff and erosion. Increased erosion can ultimately alter drainage characteristics and water quality if eroded material reaches drainages. Impacted soils identified as having high hazards for wind and water erosion can amplify the effects of CBM development.

Wind Erosion Hazard

Wind erosion groups are based on soil texture (grain size, parent material, cohesiveness, and wetness) and indicate the susceptibility of a soil to wind erosion. Nine groupings have been developed (1, 2, 3, 4, 4L, 5, 6, 7, and 8). The lower the number, the greater the risk of wind erosion. Group 1 includes soils that consist entirely of fine sand, which is highly susceptible to wind erosion. Group 8 contains very wet or stony soils, which are not at all subject to wind erosion. Soils listed in Groups 1 and 2 are considered severe hazards (Natural Resources Conservation Service [NRCS] 2002).

Severe wind erosion hazards are primarily found in steep areas along ridges and hillsides. The exception is the Fluvaquent soils, which are found in the floors of recent alluvial valleys (Figure 3–31). Figure 3–31 shows the portions of the Project Area where the potential for wind erosion is high.

Water Erosion Hazard

Water erosion hazards are identified using permeability classes, K-factor, and slope category. Slopes between 25 and 40 percent are considered moderate water erosion hazards and slopes greater than 40 percent are considered severe water erosion hazards no matter what soil type occurs.

K-factor is one of six factors used in the RUSLE to predict the annual rate of soil loss caused by water erosion. Soil structure, percentage of silt, sand, organic matter, and permeability all affect the K-factor of a soil (Bauer et al. 1981). Values for K range from 0.02 to 0.69. The susceptibility of soil to water erosion increases as the value rises. Soils with low permeability and high K-factors were considered severe water erosion hazards for slope ranges between 0 percent and 25 percent (NRCS 2002).

Water erosion varies considerably among soil types for slopes of 25 percent or less. Therefore, permeability class and K-factor for each soil type are used to identify the soils that might be more susceptible to water erosion on gentle topography. At slopes less than 5 percent, only soils that are the least permeable and have been assigned the highest K-factor are susceptible to water erosion. At slopes greater than 25 percent, only soils that are the most permeable and have been assigned the lowest K-factor are not susceptible to water erosion (NRCS 2002).

Soil permeability classes are assigned by infiltration rates expressed in inches per hour. Rates from 0 to 0.2 inches/hour were considered slow, 0.2 through 6.0 inches/hour moderate, and 6.0 inches/hour and greater were considered rapid (Soil Conservation Service 1994). Generally, rates of infiltration are highest in primarily sandy soils and very slow in clayey soils.

Soils with severe potential for water erosion occur in all types of terrain, from mountainsides and cliffs to valley bottoms. Figure 3–31 shows the portions of the Project Area where the potential for water erosion is high. The guidelines discussed for evaluating water erosion hazards are general; actual loss of soil depends on many other factors, such as vegetative cover, which may make soils more or less susceptible to water erosion than is described.

Soils derived from the Animas Formation, called collapsible, are unique in that they exhibit high potential for dispersion of soil. Soil dispersion is the tendency to go into solution rapidly when exposed to water, which promotes rapid erosion (Poitras and Trautner 2001). These soils are located downslope from areas where the Animas Formation reaches the surface (Figure 3–31), such as drainages in the watersheds of the Florida, Los Pinos, and Piedra Rivers.

RUSLE was used to estimate soil loss for the Project Area to approximate potential sedimentation levels. The five factors used in RUSLE are as follows:

- R, the rainfall and runoff factor for the area;
- K, the soil erodibility factor (discussed previously in the section on water erosion hazard);
- LS, a combination of the slope length and slope steepness;
- C, the cover management factor;
- P, the erosion control practice factor (Renard et al. 1997).

Separate RUSLE calculations were made for each watershed in the Project Area to create a relatively site-specific estimate of soil loss. Boundaries of the watersheds in the Project Area were delineated using HUC 5 coverage for the area. The watershed boundaries are shown on Figure 3–26. All factors except for K and LS were assumed to be constant throughout each watershed. Two values for C were used for each watershed equation. The first value, 0.45, was used to reflect areas where soils are bare and completely exposed, such as access roads or well pads. The second C value, 0.013, was used to reflect areas that contain native vegetative covér and that are unaffected by CBM development. An R-value of 15 was used as a constant for the entire Project Area, obtained from the Isoerodent Map of the Western United States found in the RUSLE handbook. The most conservative factor of 1 for P values (recommended by the RUSLE handbook for areas of irregular slope) was used to represent a worst-case scenario for the erosion control practice. The K value for each watershed was derived by calculating a weighted average of the K factors for each soil type represented in that watershed. The LS values for each watershed were derived by incorporating the average slope percentage within each watershed with a general representative slope length of 500 feet (Redders 2003). Table 3-39 shows the values for K and LS used in the calculations for the various watersheds.

Table 3-39 Summary of K and LS Values Used in Calculations Made with the Revised Universal Soil Loss Equation

Watershed	K Value	LS Value
Lower Florida River	0.28	2.13
Middle Animas Valley	0.0.31	3.76
Middle Los Pinos River	0.22	3.5
Beaver Creek	0.26	5
Lower Los Pinos River	0.29	6.55
Lower Piedra River	0.0.13	10
Navajo Reservoir Inlet	0.37	5.77
Lower Stollsteimer Creek	0.23	8.46

Based on the RUSLE calculation (multiplication of all factors), average annual soil losses vary by watershed (Table 3-40). The Lower Florida River watershed is expected to lose the smallest amount of soil from surface disturbances. In contrast, the Lower Los Pinos River, Navajo Reservoir Inlet, and Stollsteimer Creek watersheds are expected to lose the greatest amount of soil from surface disturbances.

The total annual soil loss expected from existing CBM development disturbance was then estimated by multiplying the estimated soil loss per ton calculated in RUSLE by the acres disturbed by existing CBM facilities. Table 3-41 summarizes estimated annual soil loss by watershed. Sixty percent of the estimated annual soil loss generated from existing disturbance occurs in the Beaver Creek and Lower Los Pinos River watersheds. The Lower Piedra River watershed accounts for another 15 percent of the annual soil loss generated from existing disturbance in the Project Area. Existing CBM disturbance on National Forest occurs in the Beaver Creek, lower Los Pinos River, and lower Piedra River watersheds. Within

the three watersheds existing CBM development results in 2,900 tons of annual soil loss from approximately 400 acres. Existing soil loss on BLM lands totals 350 tons per year from approximately 50 acres (Table 3-41).

Table 3-40 Summary of Estimated Average Annual Soil Loss for Undisturbed, Vegetated Soils and Bare Soils, by Watershed

	Average Annual Soil Loss from: (tons/acre)	
Watershed	Undisturbed Vegetated Soil	Bare Soil
Lower Florida River	0.08	2.7
Middle Animas Valley	0.21	7.1
Middle Los Pinos River	0.15	5.2
Beaver Creek	0.26	9.1
Lower Los Pinos River	0.38	13.0
Lower Piedra River	0.27	9.2
Navajo Reservoir Inlet	0.42	14.0
Stollsteimer Creek	0.38	13.0

Sedimentation in rivers and streams in the Project Area is an important result of soil loss, but cannot be adequately estimated simply by calculating soil loss. The sedimentation load depends on whether eroded soil can reach the drainages. Relief, climate, vegetation, and bedrock geology all work to block or facilitate the transport of sediment to surface water. Based on these characteristics, there is a large difference between soil loss and sedimentation in surface water drainages.

WIZs were delineated to evaluate areas of elevated soil erosion impacts resulting from CBM surface disturbance within the Project Area. Main drainages (1st order), such as the Animas, Florida, Los Pinos, and Piedra Rivers, were assigned a WIZ of 300 feet on either side. Smaller tributaries (2nd through 7th order), such as Beaver Creek, Sauls Creek, and Springs Creek, were assigned a WIZ of 100 feet on either side. The effects of soil erosion are elevated within the WIZ because eroded sediment is expected to reach the drainages and could cause changes in the quality of the water flowing through the drainage. The WIZ are described in more detail in the Surface Water Resources Section of this chapter.

Approximately 194 acres of existing surface disturbance from CBM development fall within the WIZ in the Project Area. Of that total, three acres of impacted WIZ are on National Forest and one acre is on BLM lands.

3.7.2.2.2 Effects of CBM Development to Date

Of the acreage disturbed by existing CBM operations, about 42 acres involve soils with high potential for wind erosion and 93 acres involve soils with high potential for water erosion. Soil loss within the Project Area as a result of existing CBM development is estimated to be 11,400 tons per year. The total soil loss expected to have occurred within the WIZ as a result of existing CBM development is approximately 1,638 tons per year (Table 3-41). This loss is in addition to soil losses resulting from natural processes. Of the above total, soil loss on National Forest as a result of existing CBM development is estimated to be

3,000 tons per year and existing soil loss on BLM lands is 350 tons per year. Current oil loss within the WIZ on federal jurisdiction is minimal (Table 3-41). These effects have been minimized using BMPs. Loss of soil caused by wind and water erosion has been reduced by revegetating portions of well pads not needed for production immediately after construction. Maintaining original flow patterns as much as possible and installing slope breaks and silt fences on slopes near CBM facilities has also minimized soil loss caused by water erosion.

Table 3-41 Estimated Annual Soil Loss from Existing CBM Disturbance, by Watershed

Watershed	Existing Surface Disturbance (acres)	Existing Surface Disturbance Within WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Estimated Annual Soil Loss From Existing Disturbance (tons)	Annual Soil Loss From Existing disturbance Within WIZ
Project Area					
Lower Florida River	359	29	2.7	969	78
Middle Animas Valley	88	7	7.1	625	50
Middle Los Pinos River	234	25	5.2	1,217	130
Beaver Creek	330	61	9.1	3,003	555
Lower Los Pinos River	296	26	13.0	3,848	338
Lower Piedra River	176	42	9.4	1,654	395
Navajo Reservoir Inlet	0	0	14.0	0	0
Stollsteimer Creek	7	4	13.0	91	52
Total[2]	1,490	194		11,407	1,638
National Forest					
Lower Florida River	0	0	2.7	0	0
Middle Animas Valley	0	0	7.1	0	0
Middle Los Pinos River	0	0	5.2	0	0
Beaver Creek	161	2	9.1	152	18
Lower Los Pinos River	115	0	13.0	1495	0
Lower Piedra River	138	1	9.4	1297	9
Navajo Reservoir Inlet	0	0	14.0	0	0
Stollsteimer Creek	4	0	13.0	52	0
Total[2]	418	3		2996	27
BLM					
Lower Florida River	23	1	2.7	62	3
Middle Animas Valley	9	0	7.1	64	0
Middle Los Pinos River	2	0	5.2	10	0
Beaver Creek	0	0	9.1	0	0
Lower Los Pinos River	16	0	13.0	208	0
Lower Piedra River	0	0	9.4	0	0
Navajo Reservoir Inlet	0	0	14.0	0	0
Stollsteimer Creek	0	0	13.0	0	0
Total[2]	50	1		344	3

Notes:

1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Does not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development.

Note: WIZ = watershed influence zone

3.7.2.3 CBM Development and Topsoil Loss

3.7.2.3.1 Concerns

Loss of topsoil has already been discussed in Section 3.7.2.2. However, in addition to sedimentation and decreasing slope stability, the loss of topsoil is important in its negative effect on forestry, agriculture, and wildlife. These effects are mostly related not to the loss of topsoil itself, but to the loss of soil productivity. In addition, the potential for revegetation during reclamation becomes the central issue in considering the effects of soil loss as well pads and roads are completely cleared of vegetation during development of CBM and are eventually reclaimed. Two categories related to soil productivity, potential for revegetation and prime farmland, are identified in the soil surveys. Figure 3–32 shows the portions of the Project Area where revegetation potential is low and where prime farmland is designated.

Potential for Revegetation

The potential for revegetation of soils was evaluated using the land capability classification. Soils were grouped according to limitations for field crops, risk of damage if used for agriculture, and response to management. Capability classes were divided into eight groups (Roman numerals I through VIII), with few limitations for Class I soils and multiple limitations that prevent commercial crop production for Class VIII soils. Class VII and Class VIII soils have been determined to have poor potential for revegetation (NRCS 2002).

Soils with poor revegetation potential are shallow, rocky soils, which occur primarily in steep areas, such as canyon walls, mesa edges, ridges, and hillsides. The exception is the Fluvaquent soils, which are found in recent alluvial valley floors (Figure 3–30).

Prime Farmland

The prime farmland designation is based on the soil type, regardless of current land use. The U.S. Department of Agriculture (USDA) has identified and located lands of national importance, including prime and unique farmlands, and farmlands of state and local importance.

Prime and unique farmlands and farmlands of state and local importance located within Colorado are delineated in the La Plata Survey. The Piedra Area Survey did not list prime farmlands, but the lack of irrigation in the area precludes soils in this survey from classification as prime farmland (Bauer et al. 1981).

Irrigation in the Project Area occurs along the Los Pinos and Florida Rivers. Only the irrigated soils in a small area along the upper section of the Florida River in the Project Area and near Bayfield are considered prime farmland.

3.7.2.3.2 Effects of CBM Development to Date

Of the acreage disturbed by existing CBM operations, about 134 acres are on soils with poor potential for revegetation and 53 acres are on prime agricultural soils (Table 3-42). There is a greater potential for topsoil loss in the areas where revegetation is unsuccessful because the soils remain vulnerable to wind and water erosion. Prime farmland is removed from productivity or the future potential

to be productive when CBM facilities are constructed on the soils. These effects on disturbed soils with low potential for revegetation and on prime farmland have been minimized using BMPs (Appendix F), such as seeding with aggressive, stabilizing plant species.

Table 3-42 Summary of Effects to High-hazard Soils, by Alternative

		Soils Hazards			
	Total Surface Disturbance[1]	Water Erosion	Wind Erosion	Poor Revegetation	Prime Farmland
Existing	1,496	93	42	134	53
Project Area					
Alternative 1					
Short Term	1,113	140	51	348	24
Long term	684	89	34	228	16
Alternative 2					
Short Term	1,843	316	92	664	39
Long term	1,171	206	62	440	27
Alternative 5					
Short Term	756	67	44	161	24
Long term	474	45	30	107	16
Alternative 6					
Short Term	614	77	48	214	24
Long term	428	53	33	143	16
Alternative 7					
Short Term	807	102	49	285	24
Long term	545	67	33	189	16
National Forest					
Alternative 1					
Short Term	701	77	5	218	0
Long term	195	47	4	139	0
Alternative 2					
Short Term	1128.4	174	9	367	0
Long term	139	110	6	239	0
Alternative 5					
Short Term	107.5	5	1	52	0
Long term	68	3	1	33	0
Alternative 6					
Short Term	318	15	3	89	0
Long term	224	11	2	59	0
Alternative 7					
Short Term	500	24	3	142	0
Long term	334	16	2	92	0
BLM					
Alternative 1					
Short Term	63	18	12	51	0
Long term	43	12	9	35	0
Alternative 2					
Short Term	135	46	26	97	3
Long term	91	31	18	66	2
Alternative 5					
Short Term	23	8	5	16	0
Long term	16	5	4	11	0
Alternative 6					
Short Term	59	18	12	45	0
Long term	40	12	9	32	0
Alternative 7					
Short Term	63	18	12	51	0
Long term	43	12	9	35	0

3.7.3 Environmental Consequences

3.7.3.1 Impacts Common to All Alternatives

Short-term and long-term soils impacts would result from various activities during the construction, drilling, production, and reclamation phases of the project. These potential effects are evaluated on the basis of maximum estimated surface disturbance for each alternative, which was calculated using approximate locations of gas well pads, access roads, pipelines, produced water disposal wells, trunk pipelines, and compressor stations. Short-term and long-term surface disturbance is also a function of the number of wells the companies drill from each pad. During construction, tractor dozers, tractor backhoes, and road graders would strip the area of vegetation, dig and stockpile topsoil for reclamation, and then roughly grade the general contour of the road, pad, or pipeline ROW using standard cut-and-fill techniques. Gravel trucks would transport and place coarse subsurface gravel and finer surface gravel on the road surfaces and the areas of the pads where heavy equipment would be used.

Activities and conditions that would cause long-term impacts to soils include periodic maintenance of access roads and routine daily inspection and maintenance of gas wells, injection wells, compressor stations, and pipelines. Routine maintenance of access roads could involve additions of gravel and blading in the summer and blading of snow and some additions of gravel where necessary and permitted by weather conditions in the winter. When the project is complete, all roads constructed specifically for the project would be removed and reclaimed by re-contouring, plowing, and seeding. All surface facilities and gravel surfaces on the gas well pads, compression station pads, and injection well pads would be removed. Topsoil that was stockpiled previously would be spread on the disturbed portions of the pads. Erosion control features would be installed as necessary. Underground gas and produced water pipelines and electric transmission lines would be abandoned in place to avoid unnecessary disturbance of the surface soil.

Following are discussions of estimated short-term and long-term soil impacts under each alternative.

3.7.3.2 CBM Development and Soil Erosion

3.7.3.2.1 Alternative 1 — Proposed Action

Construction of CBM facilities would result in exposed soils and increase erosion, especially in areas that contain soils with high potential for water and wind erosion. Increased erosion may ultimately alter drainage characteristics and water quality if eroded sediment reaches drainages. Aquatic wildlife habitats, some domestic drinking water supplies, and irrigation systems may be affected by this sedimentation.

During construction, Alternative 1 in total would affect 140 acres with high potential for water erosion and 51 acres of soils with high potential for wind erosion, with some overlap of soils exhibiting both hazards (Table 3-42). On National Forest, CBM development would impact 77 acres with high potential for water erosion and 5 acres of soils with high potential for wind erosion. CBM de-

velopment on BLM lands would impact 18 acres with high potential for water erosion and 12 acres of soils with high potential for wind erosion.

During operation and maintenance, Alternative 1 in total would affect 89 acres with high water erosion potential and 34 acres of soils with high wind erosion potential. These erosive soils are mostly concentrated in the western portion of the Project Area between the western boundary of the Fruitland Outcrop and Bayfield, southeast of County Road (CR) 502, as well as in the HD Mountains and along the drainages of the Florida, Piedra, and Los Pinos Rivers and their tributaries (Figure 3–31). There are also patches of wind and water erosive soils west of the La Plata County line and south of Bayfield. Construction, operation, and decommissioning of CBM facilities would cause greater soil erosion in these areas than in areas with lower potential for wind and water erosion. Heavy equipment traffic over barren and exposed soils on well pads, access roads, and other CBM facilities would loosen erosive soils, making them even more vulnerable to transport off-site by water and wind.

The total soil loss expected during construction is estimated using RUSLE and the acreage impacted in each watershed. Table 3-43 shows the estimated amount of soil erosion within each watershed as a result of Alternative 1.

A total of 30,300 tons of soil are estimated to erode naturally from undisturbed portions of the Project Area each year. Alternative 1 would increase this level of erosion by 9,763 tons per year (32 percent) during the construction phase of the project. Eighty-seven percent of the soil projected to erode during construction would occur within the Beaver Creek, Lower Los Pinos River, and Lower Piedra River watersheds, encompassing all of the HD Mountains. The Middle Animas watershed would experience the least amount of soil erosion (Table 3-43). With partial reclamation of disturbed areas, erosion would equal approximately 6,437 tons per year (21 percent) increase over existing conditions during the operation and maintenance phase of the project. Similar to the construction phase, the Beaver Creek, Lower Los Pinos River, and Lower Piedra River watersheds would experience the greatest amount of soil erosion during operation and maintenance. The potential for soil loss, therefore, would be greatest on National Forest in the HD Mountains area.

Projected soil erosion on National Forest and BLM lands would be approximately 7,100 tons and 580 tons per year, respectively, during the construction phase and of lesser amount during the operation and maintenance phase of the project (Table 3-43).

Table 3-43 Estimated Annual Soil Loss by Watershed Resulting from Alternative 1

Watershed	Short-Term Disturbance (acres)	Short-Term Disturbance in WIZ (acres)	Long-Term Disturbance (acres)	Long-Term Disturbance in WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Annual Short-Term Soil Loss (tons)	Annual Short-Term Soil Loss in WIZ (tons)	Annual Long-Term Soil Loss (tons)	Annual Long-Term Soil Loss in WIZ (tons)
Project Area									
Lower Florida River	53	6	36	4	2.7	143	16	97	11
Middle Animas Valley	13	0	10	0	7.1	92	0	71	0
Middle Los Pinos River	65	8	45	5	5.2	338	42	234	26
Beaver Creek	144	12	97	9	9.1	1,310	109	883	82
Lower Los Pinos River	201	9	137	6	13.0	2,613	117	1,781	78
Lower Piedra River	487	55	313	35	9.4	4,578	517	2,942	329
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	53	6	33	3	13.0	689	78	429	39
Total[2]	1,016	94	672	62		9,763	879	6,437	565
National Forest									
Lower Florida River	0	0	0	0	2.7	0	0	0	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	0	0	0	0	5.2	0	0	0	0
Beaver Creek	98	1	66	0	9.1	892	9	601	18
Lower Los Pinos River	111	4	77	2	13.0	1,443	52	1,001	26
Lower Piedra River	453	50	289	32	9.4	4,258	470	2,717	301
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	39	4	24	2	13.0	507	52	312	26
Total[2]	701	59	456	36		7,100	583	4,631	371
BLM									
Lower Florida River	16	3	11	2	2.7	43	8	30	5
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	8	0	6	0	5.2	42	0	31	0
Beaver Creek	3	3	2	2	9.1	27	27	18	18
Lower Los Pinos River	36	3	24	2	13.0	468	39	312	26
Lower Piedra River	0	0	0	0	9.4	0	0	0	0
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	63	9	51	6		580	74	391	49

Notes:
1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Totals for short and long-term disturbance do not include acreages of disturbance predicted from windows for yet undetermined road locations (See Table 2–1 in Chapter 2). Totals for short and long-term erosion do not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development

Alternative 1 would result in surface disturbance and erosion in almost all WIZs. Ninety-four acres of WIZ (9 percent of the total surface disturbance under Alternative 1) would be impacted during the construction phase of the project, resulting in 879 tons of soil erosion per year. After partial reclamation, approximately

565 tons of soil erosion would occur per year, or 9 percent of the total soil expected to erode as a result of activities under Alternative 1. A significant portion of the soil eroded from the WIZ could reach surface water drainages in the absence of mitigation, may impair water quality, and may potentially impact aquatic wildlife habitats, some domestic drinking water supplies, and irrigation systems. The effects to water quality are discussed in more detail in the Surface Water section of this chapter. The potential for soil loss and sedimentation impacting surface water would be greatest in the HD Mountains area.

Soil erosion would be limited by implementing standard mitigation measures, which are described in Section 3.7.5 and Appendix F. These measures include slope breakers, silt fencing, drainage dips, timely reclamation, and seeding of stockpiles that remain for extended periods. Road and well pad surfaces would be graveled to mitigate wind erosion. Heavy equipment would not be allowed on federal lands, other than on main service roads or when the soil is saturated (that is, when the moisture content exceeds the plastic limit), which would limit water erosion on exposed soils. CBM-related vehicular traffic would be limited to the traveled surfaces of access roads identified in the APD.

3.7.3.2.2 Alternative 2

Alternative 2 would result in greater soil erosion than Alternative 1 because of the higher level of development and impact to areas prone to erosion. Alternative 2 would affect 327 acres of soils with high potential for water erosion and 92 acres of soils with high potential for wind erosion in the short term (with some overlap on soils that exhibit both characteristics). Two hundred and sixteen acres of soils with high potential for water erosion and 62 acres of soils with high potential for wind erosion (with some overlap) would remain impacted in the long term after partial reclamation. Soil loss would be mitigated partially by limiting CBM-related vehicular traffic to the access roads, wetting down and compacting access road surfaces where dust is an issue, revegetating soil stockpiles that would remain for long periods, installing erosion control devices (slope breakers and silt fences) on slopes where soils are exposed, and reclaiming impacted surfaces in a timely manner.

Table 3-44 shows the estimated annual tons of soil erosion within each watershed as a result of Alternative 2. An estimated 30,113 tons of soil are estimated to erode naturally from undisturbed portions of the Project Area each year. Alternative 2 would increase erosion by 16,265 tons per year (54 percent) during the construction phase of the project. With partial reclamation, erosion would drop to 10,787 tons per year (36 percent) over existing conditions during the operation and maintenance phase of the project. Projected soil erosion on National Forest and BLM lands would be approximately 11,700 tons and 610 tons per year, respectively, during the construction phase and of lesser amount during the operation and maintenance phase of the project (Table 3-44).

Table 3-44 Estimated Annual Soil Loss by Watershed Resulting from Alternative 2

Watershed	Short-Term Disturbance (acres)	Short-Term Disturbance in WIZ (acres)	Long-Term Disturbance (acres)	Long-Term Disturbance in WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Annual Short-Term Soil Loss (tons)	Annual Short-Term Soil Loss in WIZ (tons)	Annual Long-Term Soil Loss (tons)	Annual Long-Term Soil Loss in WIZ (tons)
Project Area									
Lower Florida River	138	13	93	9	2.7	373	35	251	24
Middle Animas Valley	71	0	49	0	7.1	504	0	348	0
Middle Los Pinos River	122	13	84	9	5.2	634	68	437	47
Beaver Creek	404	38	270	27	9.1	3,676	346	2,457	246
Lower Los Pinos River	379	35	256	23	13.0	4,927	455	3,328	299
Lower Piedra River	570	58	368	37	9.4	5,358	545	3,459	348
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	61	8	39	5	13.0	793	104	507	65
Total[2]	1,745	165	1,359	150		16,265	1,553	10,787	1,029
National Forest									
Lower Florida River	0	0	0	0	2.7	0	0	0	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	0	0	0	0	5.2	0	0	0	0
Beaver Creek	270	16	179	11	9.1	2,457	146	1,629	100
Lower Los Pinos River	267	30	181	20	13.0	3,471	390	2,353	260
Lower Piedra River	540	52	346	33	9.4	5,076	489	3,252	310
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	52	6	33	3	13.0	676	78	429	39
Total[2]	1,129	104	739	67		11,680	1,103	7,663	709
BLM									
Lower Florida River	52	3	35	2	2.7	140	8	95	5
Middle Animas Valley	24	2	16	0	7.1	170	14	114	0
Middle Los Pinos River	19	0	13	0	5.2	99	0	68	010
Beaver Creek	5	3	4	2	9.1	46	27	36	18
Lower Los Pinos River	35	3	24	2	13.0	455	39	312	26
Lower Piedra River	0	0	0	0	9.4	0	0	0	0
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	135	11	92	6		910	88	625	59

Notes:
1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Totals for short and long-term disturbance do not include acreages of disturbance predicted from windows for yet undetermined road locations (See Table 2–5 in Chapter 2). Totals for short and long-term erosion do not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development.

Alternative 2 would result in surface disturbance and erosion in almost all WIZs. One hundred and sixty five acres of WIZ would be impacted during the construction phase of the Project. About 1,553 tons of soil per year would erode from WIZs as a result of construction activities. After partial reclamation, there would be 150 acres remaining impacted during the operation and maintenance phase

and an expected 1,029 tons of soil eroded per year within the WIZs. A portion of the soil eroded from the WIZ would be expected to reach surface water drainages and may impair water quality. The potential for soil erosion within the WIZ and the potential for that eroded soil to impact surface water quality would be significantly greater under Alternative 2 than Alternative 1.

3.7.3.2.3 Alternative 5 — No Action

Alternative 5 would impact 66 acres of soils with high potential for water erosion and 44 acres of soils with high potential for wind erosion (with some overlap on soils exhibiting both hazards) during the construction phase of the project The potential for soil erosion caused by water and wind would be the lowest of all alternatives, because additional CBM development would not proceed on federal leases at this time.

Table 3-45 shows the estimated annual tons of soil erosion within each watershed as a result of Alternative 5. An estimated 30,494 tons of soil are expected to erode naturally from undisturbed portions of the Project Area each year. Alternative 5 would increase erosion by an estimated 3,108 tons per year (10 percent) during the construction phase of the project. With partial reclamation erosion would drop to 2,091 tons per year (7 percent) over existing conditions during the operation and maintenance phase of the project.

Fifty acres would be disturbed within the WIZ during the construction phase of the project, resulting in 431 tons per year of erosion. The potential for soil erosion and subsequent impairment of surface water quality would be lowest under Alternative 5.

3.7.3.2.4 Alternative 6

Alternative 6 would result in significantly less soil erosion than Alternative 1 because of the exclusion of proposed wells and roads from surface locations within the HD Mountains Roadless Area and the exclusion of CBM development of federal mineral leases within the Fruitland formation outcrop buffer zone. Alternative 6 would affect 77 acres of soils with high potential for water erosion and 48 acres of soils with high potential for wind erosion in the short term (with some overlap on soils that exhibit both characteristics). Fifty-three acres of soils with high potential for water erosion and 33 acres of soils with high potential for wind erosion (with some overlap) would remain impacted in the long term after partial reclamation. Soil loss would be mitigated partially by limiting CBM-related vehicular traffic to the access roads, wetting down and compacting access road surfaces where dust is an issue, revegetating soil stockpiles that would remain for long periods, installing erosion control devices (slope breakers and silt fences) on slopes where soils are exposed, and reclaiming impacted surfaces in a timely manner.

Table 3-45 Estimated Annual Soil Loss by Watershed Resulting from Alternative 5

Watershed	Short-Term Disturbance (acres)	Short-Term Disturbance in WIZ (acres)	Long-Term Disturbance (acres)	Long-Term Disturbance in WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Annual Short-Term Soil Loss (tons)	Annual Short-Term Soil Loss in WIZ (tons)	Annual Long-Term Soil Loss (tons)	Annual Long-Term Soil Loss in WIZ (tons)
Project Area									
Lower Florida River	44	3	30	2	2.7	119	8	81	5
Middle Animas Valley	13	0	10	0	7.1	92	0	71	0
Middle Los Pinos River	62	8	43	5	5.2	322	42	224	26
Beaver Creek	54	11	37	8	9.1	491	100	337	73
Lower Los Pinos River	88	5	59	4	13.0	1,144	65	767	52
Lower Piedra River	100	23	65	15	9.4	940	216	611	141
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	362	50	244	34		3,108	431	2,091	297
National Forest									
Lower Florida River	0	0	0	0	2.7	0	0	0	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	0	0	0	0	5.2	0	0	0	0
Beaver Creek	5	0	4	0	9.1	46	0	36	0
Lower Los Pinos River	2	0	2	0	13.0	26	0	26	0
Lower Piedra River	101	20	62	12	9.4	949	188	583	113
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	108	20	68	12		1,021	188	645	113
BLM									
Lower Florida River	8	0	5	0	2.7	22	0	14	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	3	0	2	0	5.2	16	0	10	0
Beaver Creek	3	3	2	2	9.1	27	27	18	18
Lower Los Pinos River	10	3	7	2	13.0	130	39	91	26
Lower Piedra River	0	0	0	0	9.4	0	0	0	0
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	24	6	16	4		180	66	123	144

Notes:
1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Totals for short and long-term disturbance do not include acreages of disturbance predicted from windows for yet undetermined road locations (See Table 2–9 in Chapter 2). Totals for short and long-term erosion do not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development.

Table 3-46 shows the estimated annual tons of soil erosion within each watershed as a result of Alternative 6. An estimated 30,113 tons of soil are estimated to erode naturally from undisturbed portions of the Project Area each year. Alternative 6 would increase erosion by 5,673 tons per year (19 percent) during the construction phase of the project. With partial reclamation, erosion would drop to 3,959 tons per year (13 percent) over existing conditions during the operation and maintenance phase of the project (Table 3-46).

Table 3-46 Estimated Annual Soil Loss by Watershed Resulting from Alternative 6

Watershed	Short-Term Disturbance (acres)	Short-Term Disturbance in WIZ (acres)	Long-Term Disturbance (acres)	Long-Term Disturbance in WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Annual Short-Term Soil Loss (tons)	Annual Short-Term Soil Loss in WIZ (tons)	Annual Long-Term Soil Loss (tons)	Annual Long-Term Soil Loss in WIZ (tons)
Project Area									
Lower Florida River	50	3	34	2	2.7	135	8	92	5
Middle Animas Valley	13	0	10	0	7.1	92	0	71	0
Middle Los Pinos River	64	8	44	5	5.2	333	42	229	26
Beaver Creek	120	13	87	10	9.1	1,092	118	792	91
Lower Los Pinos River	177	9	126	6	13.0	2,301	117	1,638	78
Lower Piedra River	183	27	121	17	9.4	1,720	254	1,137	160
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	607	60	422	40		5,673	539	3,959	360
National Forest									
Lower Florida River	0	0	0	0	2.7	0	0	0	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	0	0	0	0	5.2	0	0	0	0
Beaver Creek	68	2	50	2	9.1	619	18	456	18
Lower Los Pinos River	85	4	64	2	13.0	1,105	52	832	26
Lower Piedra River	165	24	110	15	9.4	1,551	226	1,034	141
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	318	30	224	19		3,275	296	2,322	185
BLM									
Lower Florida River	13	0	9	0	2.7	35	0	24	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	7	0	5	0	5.2	36	0	26	0
Beaver Creek	3	3	2	2	9.1	27	27	18	18
Lower Los Pinos River	36	3	24	2	13.0	468	39	312	26
Lower Piedra River	0	0	0	0	9.4	0	0	0	0
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	59	6	40	4		566	66	380	44

Notes:

1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Totals for short and long-term disturbance do not include acreages of disturbance predicted from windows for yet undetermined road locations (See Table 2–9 in Chapter 2). Totals for short and long-term erosion do not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development.

Projected soil erosion on National Forest and BLM lands would be approximately 3,275 tons and 570 tons per year, respectively, during the construction phase and of lesser amount during the operation and maintenance phase of the project (Table 3-46).

Alternative 6 would result in surface disturbance and erosion in most WIZs, with the exception of the Middle Animas, Stollsteimer Creek, and Navajo Reservoir Watersheds). Sixty acres of WIZ would be impacted during the construction phase of the Project. About 539 tons of soil per year would erode from WIZs as a result of construction activities. After partial reclamation, there would be 40 acres remaining impacted during the operation and maintenance phase and an expected 360 tons of soil eroded per year within the WIZs. A portion of the soil eroded from the WIZ would be expected to reach surface water drainages and may impair water quality. The potential for soil erosion within the WIZ and the potential for that eroded soil to impact surface water quality would be significantly lower under Alternative 6 than Alternative 1.

3.7.3.2.5 Alternative 7

Alternative 7 would result in less soil erosion than Alternative 1 because of the exclusion of surface development of 35 well locations within portions of the HD Mountains Roadless Area. Alternative 7 would affect 102 acres of soils with high potential for water erosion and 49 acres of soils with high potential for wind erosion in the short term (with some overlap on soils that exhibit both characteristics). Sixty-seven acres of soils with high potential for water erosion and 33 acres of soils with high potential for wind erosion (with some overlap) would remain impacted in the long term after partial reclamation. Soil loss would be mitigated partially by limiting CBM-related vehicular traffic to the access roads, wetting down and compacting access road surfaces where dust is an issue, revegetating soil stockpiles that would remain for long periods, installing erosion control devices (slope breakers and silt fences) on slopes where soils are exposed, and reclaiming impacted surfaces in a timely manner.

Table 3-47 shows the estimated annual tons of soil erosion within each watershed as a result of Alternative 7. A total of 30,113 tons of soil are estimated to erode naturally from undisturbed portions of the Project Area each year. Alternative 7 would increase erosion by 7,638 tons per year (25 percent) during the construction phase of the project. With partial reclamation, erosion would drop to 5,155 tons per year (17 percent) over existing conditions during the operation and maintenance phase of the project.

Projected soil erosion on National Forest and BLM lands would be approximately 5,160 tons and 580 tons per year, respectively, during the construction phase and of lesser amount during the operation and maintenance phase of the project (Table 3-47).

Table 3-47 Estimated Annual Soil Loss by Watershed Resulting from Alternative 7

Watershed	Short-Term Disturbance (acres)	Short-Term Disturbance in WIZ (acres)	Long-Term Disturbance (acres)	Long-Term Disturbance in WIZ (acres)	Estimated Annual Soil Loss (tons per acre)[1]	Annual Short-Term Soil Loss (tons)	Annual Short-Term Soil Loss in WIZ (tons)	Annual Long-Term Soil Loss (tons)	Annual Long-Term Soil Loss in WIZ (tons)
Project Area									
Lower Florida River	53	6	36	4	2.7	143	16	97	11
Middle Animas Valley	13	0	10	0	7.1	92	0	71	0
Middle Los Pinos River	65	8	45	5	5.2	338	42	234	26
Beaver Creek	125	11	86	9	9.1	1,138	100	783	82
Lower Los Pinos River	190	9	131	6	13.0	2,470	117	1,703	78
Lower Piedra River	318	39	208	26	9.4	2,989	367	1,955	244
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	36	4	24	2	13.0	468	52	312	26
Total[2]	800	77	540	52		7,638	694	5,155	467
National Forest									
Lower Florida River	0	0	0	0	2.7	0	0	0	0
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	0	0	0	0	5.2	0	0	0	0
Beaver Creek	73	1	50	0	9.1	664	9	455	0
Lower Los Pinos River	98	4	69	2	13.0	1,274	52	897	26
Lower Piedra River	294	34	192	23	9.4	2,764	320	1,805	216
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	35	0	24	0	13.0	455	0	312	26
Total[2]	500	39	335	27		5,157	381	3,469	268
BLM									
Lower Florida River	16	3	11	2	2.7	43	8	30	5
Middle Animas Valley	0	0	0	0	7.1	0	0	0	0
Middle Los Pinos River	8	0	6	0	5.2	42	0	31	0
Beaver Creek	3	3	2	2	9.1	27	27	18	18
Lower Los Pinos River	36	3	24	2	13.0	468	39	312	26
Lower Piedra River	0	0	0	0	9.4	0	0	0	0
Navajo Reservoir Inlet	0	0	0	0	14.0	0	0	0	0
Stollsteimer Creek	0	0	0	0	13.0	0	0	0	0
Total[2]	63	9	43	6		580	74	391	49

Notes:

1. Based on the calculations in Section 3.7.2.2 for areas that have been cleared of vegetation and the surface soils are exposed.
2. Totals for short and long-term disturbance do not include acreages of disturbance predicted from windows for yet undetermined road locations (See Table 2–9 in Chapter 2). Totals for short and long-term erosion do not include soil erosion expected to occur naturally from vegetated areas undisturbed by CBM development.

Seventy-seven acres of WIZ would be impacted during the construction phase of the Project. About 694 tons of soil per year would erode from WIZs as a result of construction activities. After partial reclamation, there would be 52 acres remaining impacted during the operation and maintenance phase and an expected 497 tons of soil eroded per year within the WIZs. A portion of the soil eroded from the WIZ would be expected to reach surface water drainages and may im-

pair water quality. The potential for soil erosion within the WIZ and the potential for that eroded soil to impact surface water quality would be lower under Alternative 7 than Alternative 1.

3.7.3.3 CBM Development and Topsoil Loss

3.7.3.3.1 Alternative 1 — Proposed Action

Aside from decreasing soil stability and increasing sedimentation, the loss of soils could negatively affect forestry, agriculture, and wildlife habitats. Revegetation potential is an important issue when considering the effects of soil loss during reclamation because absent partial or total reclamation soils would be exposed and vulnerable to erosion for many years.

During construction, 348 acres of soils with poor potential for revegetation would be impacted, and about 228 acres would remain unreclaimed during the operational and maintenance phase of the project (Table 3-42). This impact would be realized mostly in the western portion of the Project Area between the Florida and Los Pinos Rivers. Revegetation during facility reclamation could be difficult in these areas, thus, erosion could continue beyond the life of the project. Alternative 1 would impact 218 acres with poor potential for revegetation on National Forest and 51 acres with poor potential for revegetation on BLM lands.

Alternative 1 would affect 24 acres of prime farmlands along the upper section of the Florida River and near Bayfield. About 16 acres of prime farmlands would remain unreclaimed during the operational and maintenance phase of the project. Impacted prime farmlands would be removed from their prior agricultural use or from the potential to be used for agricultural purposes for the life of the project.

3.7.3.3.2 Alternative 2

Alternative 2 topsoil losses would be greater than Alternative 1. Construction would impact about 664 acres of soils with poor potential for revegetation and 39 acres of soils identified as prime farmland. About 440 acres of soils with poor potential for revegetation and 27 acres of soils classified as prime farmlands would remain impacted during the operational and maintenance phases of the project. Alternative 2 would impact 367 acres with poor potential for revegetation on National Forest and 97 acres with poor potential for revegetation on BLM lands (Table 3-42).

3.7.3.3.3 Alternative 5 — No Action

The potential for topsoil loss would be the least of all the alternatives. Project construction would affect about 151 acres of soils with poor potential for revegetation and 24 acres of prime farmland. About 102 acres of soils with poor potential for revegetation and 16 acres of prime farmland would remain impacted during the operational and maintenance phases of the project.

3.7.3.3.4 Alternative 6

Alternative 6 topsoil losses would be significantly less than Alternative 1. Construction would affect about 214 acres of soils with poor potential for revegetation and 24 acres of soils identified as prime farmland. About 143 acres of soils with poor potential for revegetation and 16 acres of soils classified as prime

farmlands would remain impacted during the operational and maintenance phases of the project. Alternative 6 would impact 89 acres with poor potential for revegetation on National Forest and 45 acres with poor potential for revegetation on BLM lands.

3.7.3.3.5 Alternative 7

Alternative 7 topsoil losses would initially be less than Alternative 1. Construction would affect about 285 acres of soils with poor potential for revegetation and 24 acres of soils identified as prime farmland. About 189 acres of soils with poor potential for revegetation and 16 acres of soils classified as prime farmlands would remain impacted during the operational and maintenance phases of the project. Alternative 7 would impact 142 acres with poor potential for revegetation on National Forest and 51 acres with poor potential for revegetation on BLM lands.

3.7.4 Cumulative Effects

The cumulative impacts of CBM development in the Project Area and surrounding areas are of concern. The cumulative effects analysis area includes the Project Area and the area where oil and gas development has and will continue to take place within the bounds of the Southern Ute Reservation. Cumulative soils impacts also result from other ground-disturbing actions including the Missionary Ridge wildfire, timber harvest, off-highway vehicle (OHV) use, agriculture and rangeland activities, and aggregate (sand and gravel) mining. Reasonably foreseeable future activities, such as projected residential, commercial, and industrial development, identified in the 2001 La Plata County Impact Report (CIR) for oil and gas development, are also considered when evaluating cumulative soils impacts.

The quantitative analysis is limited to oil and gas development, which is quantified for the entire cumulative effects analysis area. The extent and timing of some effects, especially on private lands, are difficult to quantify because of a lack of data.

Cumulative soil erosion impacts in the bounds of the SUIT Reservation are similar to the effects described for this project. CBM and conventional gas facility construction and operation, especially on soils that have high potential for wind and water erosion, would trigger increased erosion and sedimentation in surface water because of vegetation clearing, heavy equipment traffic, wind, and precipitation. Oil and gas development within the bounds of the Southern Ute Reservation would result in a maximum of 447 new wells constructed in areas of highly erosive soils, impacting a maximum of 1,368 acres (1.6 percent of the SUIT FEIS study area) in the short term and 921 acres (1.1 percent of the SUIT FEIS study area) in the long term. Existing and proposed CBM development in the Project Area under Alternative 1 would impact 153 acres on soils with high potential for wind or water erosion in the short term (less than 0.1 percent of the Project Area), and 97 acres (less than 0.1 percent of the Project Area) in the long term. Oil and gas development would cumulatively affect 1,521 acres during construction and 1,018 acres during operation and maintenance on highly erosive soils,

which is approximately 0.2 percent of the cumulative effects analysis area for both development phases.

Soil erosion impacts would be partially mitigated on both federal and Tribal jurisdictions by implementing mitigation measures that include graveling road surfaces to avoid dust and loss of soil to wind erosion; revegetating or covering any soil stockpiles that would remain for extended periods to avoid significant wind and water erosion; installing slope breaks and silt fences on slopes to slow and filter storm water runoff that might carry exposed soils to surface water drainages; timely reclamation of disturbed areas to minimize erosion after construction of facilities; and avoiding locations having highly erosive soils where possible.

The Missionary Ridge fire north of the Project Area exposed highly erosive soils in areas where vegetative cover previously held the soil in place. Since the fire, significant erosion and debris flows have occurred within the burned area. Soils eroded from the burn area, although they originate outside the cumulative impacts analysis area, reach the lower gradient channels of the Florida, Animas, and Los Pinos Rivers, and short-term changes in water quality have been observed (FS 2003a). Furthermore, the flow of water over the burn area could carry sediment into the Project Area, which would contribute to any sedimentation caused by CBM development. Reclamation and treatment in the burn area, such as aerial seeding and log erosion barriers, have mitigated some of the erosion and will continue to do so in the future until vegetation becomes reestablished. The log erosion barriers installed near Lemon Reservoir have proved successful in slowing free flow of water and sediment downslope and fostering infiltration into the soil (FS 2002a).

The projected residential, commercial, and industrial growth anticipated within the cumulative effects analysis area would all contribute to localized erosion. The impact is considered minor, however, and is not quantifiable for this study.

Soil erosion in the cumulative effects analysis area realized under Alternative 2 would be greater than the impacts discussed for Alternatives 1 and 7 because of the higher level of development in the Project Area. The increased surface disturbance would cause greater exposure of erosive soils to wind and water, resulting in higher levels of erosion. Alternative 5 would result in less soil erosion in the cumulative effects analysis area than Alternatives 1, 2, 6, and 7. Soil erosion in the cumulative effects analysis area realized under Alternatives 6 would be less than the impacts discussed for Alternatives 1 and 2 because of the exclusion of surface development within the HD Mountains Roadless Area and the exclusion of federal mineral lease development within the Fruitland outcrop buffer zone Topsoil loss from existing and proposed CBM development in the SUIT FEIS study area is similar to the impact described for the Project Area. Areas of prime farmland would be affected by conversion of land from agricultural production to gas facilities. Prime farmland occurs in the northeastern quarter of the SUIT study area. Oil and gas development within the bounds of the Reservation would result in a maximum of 30 new wells that could affect prime farmland, which would affect a maximum of 92 acres (0.44 percent of the prime farmland within the SUIT FEIS study area). Less than 1 percent of existing and proposed CBM wells in the Project Area are located on farmland used for crop production,

all in a small area along the upper section of the Florida River in the Project Area and near Bayfield.

3.7.5 Mitigation and Monitoring

Minimizing disturbance and the use of BMPs are standard practices used to reduce or eliminate the potential for mass wasting, soil erosion, soil contamination topsoil loss, and loss of soil productivity. BMPs are effective soil protection measures that have been utilized and refined by the FS and BLM over time. Unless otherwise stated, the measures would be funded by the companies and include:

- Avoid development, where possible, in areas where soils with high shrink-swell capacity, potential for compaction, or high potential for collapsibility are present.
- Avoid development, where possible, in areas where soils with high potential for water and wind erosion are present.
- Limit CBM-related vehicular traffic to the traveled surface of access roads identified in the APD.
- Wet down and compact road surfaces with gravel cover where needed to avoid dust and loss of soil to wind erosion.
- Revegetate or cover any stockpiles that would remain for extended periods and avoid depositing excavated topsoil in drainageways.
- Maintain original flow patterns as much as possible.
- Stockpile topsoil and sub-surface soil in separate areas to avoid mixing.
- Install slope breaks and silt fences on slopes.
- Implement timely reclamation to minimize loss of soil caused by water erosion.
- Investigate slope stability and avoid high construction before siting new CBM facilities.
- Loosen and rip all compacted soils on the contour. A soil is considered compacted when there is a 15 percent increase in bulk density or a 59 percent decrease in macro pore space.
- Design all new roads constructed or existing roads reconstructed on NF and BLM lands under the direction of a registered professional engineer. Utilize a geotechnical engineer to address portions of the roads that cross steep slopes or that have characteristics for mass failure of the road, the side slopes, or both.
- Design road grades at a maximum of 8 percent, except for short pitches of 300 feet or less, unless previously approved by the FS.
- Provide drainage over the entire road. Drainage usually can be accomplished by the use of dips. Ditches and culverts may be necessary to facilitate winter access.
- Close new access roads on NF and BLM land year-round to the public.
- Restrict equipment to main service roads, during periods when soils are too wet. Soils are too wet when the soil moisture content exceeds the plastic limit. If soils within 4 inches of the surface can be rolled into threads

that are 3 millimeters in diameter without breaking or crumbling, they are too wet.

Other BMPs and more site-specific mitigation measures related to soil impacts that affect surface water quality are described in Section 3.6, Surface Water Resources.

3.7.6 Conformance to Existing Plans and Policies

3.7.6.1 Conformance with FS Land Use Plans

The LRMP for the SJNF (FS 1983) establishes direction and standards, and guidelines for managing soil resources. The standards and guidelines specify ways that soils will be protected during conduct of activities on the SJNF. The standards and guidelines are followed during project planning and implementation and facility construction will adhere to the SJNF management requirements. With implementation of the mitigation measures outlined in this section and the surface water and vegetation sections during the design or siting and the operational and maintenance phases of the project, all alternatives would conform to the requirements of the LRMP for the SJNF.

3.7.6.2 Conformance with BLM Land Use Plans

The RMP for the San Juan/San Miguel Resource Areas (BLM 1985) established general objectives and guidelines for soil management to maintain productivity and minimize erosion. Soil resources are evaluated on a case-by-case basis at the project-level planning stage. Stipulations are attached as appropriate, and examples of BMPs are attached to the RMP as Appendix F.

The CBM development would conform to the RMP with the application mitigation measures specified in this and the surface water and vegetation sections during the design or siting and the operational and maintenance phases of the project.

3.7.7 Unavoidable Adverse Effects

Unavoidable adverse soils effects would occur under each of the alternatives. The extent of disturbance for Alternative 1 would be half the magnitude of Alternative 2, and greater than Alternatives 5, 6, and 7. The extent of change in physical characteristics of the soil and in erosion, sedimentation, and topsoil productivity would be greatest under Alternative 2, followed respectively by Alternatives 1, 7, 6 and 5. Vegetative cover that provides soil stability would likely not be replaced on well pads and other CBM facilities for an extended period, causing adverse impacts to soil stability and productivity. Erosion and sedimentation would occur when well pads and other CBM facilities are clear of vegetation and not yet reclaimed or where reclamation has been unsuccessful. Soils that were productively cultivated before CBM development would remain out of productivity until the area is fully reclaimed. Soils impacted by CBM development that have the potential for agricultural use could not be developed until they are fully reclaimed.

3.7.8 Irreversible and Irretrievable Effects

An irreversible or irretrievable commitment of resources would occur when soils are consumed, committed, or lost as a result of the project. The commitment of soil resources would be irreversible if the project started a process that could not be stopped. As a result, the soil or its productivity or utility would be consumed, committed, or lost forever and could not be retrieved to the areas from which it originated. There would be an irreversible commitment of soil resources when erosion occurs from CBM-disturbed areas. The erosion process would continue for an extended period, until reclamation and revegetation are successful at the end of the project. The areas where reclamation and revegetation are not successful would experience the irreversible commitment of eroded soil resources beyond the life of the project.

Commitment of a resource would be considered irretrievable when the project directly eliminates the soil, its productivity, or its utility for the life of the project and beyond. Irretrievable effects to soils would occur with the removal of vegetative cover on CBM facility pads, which would expose soils to potential erosion that would occur for the life of the project until revegetation is successful. Any soil eroded during that time would be lost forever and the characteristics of the soil at the point of erosion would change, altering the soil's stability and productivity for the life of the project and potentially beyond. Prime farmland where CBM facilities are constructed would be removed from prior or potential agricultural use for the life of the project and likely beyond.

3.8 Vegetation, Riparian Areas/Wetlands, and Old Growth Ponderosa Pine

3.8.1 Issues

Issue 8: The effect of CBM development on vegetation, including wetlands, riparian areas, and old growth ponderosa pine forests.

- What are the recovery timeframes for vegetation disturbed by CBM development?
- How will habitat structural stages (by vegetation type) be affected by CBM development?
- Will further CBM development affect quantity and quality of the groundwater and surface water and, in turn, wetlands, and riparian areas?
- How will vegetation restoration proceed in areas disturbed by CBM development?
- How will noxious weeds be controlled?
- How will old growth ponderosa pine and other old growth forest types be affected by CBM development, and can these effects be avoided or mitigated?
- How will ecological processes associated with fire and insects and disease be affected by CBM development?

Issue 16: The effects of CBM development on federal and state listed threatened, endangered, proposed, candidate, and sensitive plant species and their habitats.

3.8.2 Affected Environment

3.8.2.1 Regional Characterization

The Project Area is located along the eastern edge of the Colorado Plateau physiographic province, near the San Juan Mountains section of the Southern Rocky Mountains physiographic province (Mutel and Emerick 1992). The edge of the Colorado Plateau is distinguished by a series of mountain ranges and plateaus that are lower in elevation than the adjacent Rocky Mountains. Several rivers and smaller streams that descend from the Rocky Mountains have cut channels through these ranges.

The climate in this region is arid except at higher elevations. There, additional winter snowfall and summer thunderstorms support denser vegetation.

A variety of soils occur in the Project Area. They have developed as a result of the interactions of environmental factors, including parent material, climate, living organisms, topography, and time. Any one of these five factors can vary widely over short distances, causing large differences in properties of the soil. This variation is especially pronounced in mountainous terrain, where soils have developed in response to physiographic differences in slope, aspect, and elevation. Consequently, properties of soil are highly variable in depth, texture, organic matter, permeability, available water capacity, and cation exchange capac-

ity. The vegetation in the Project Area reflects this high range of variability in soil types.

3.8.2.2 Vegetation Types

There area nine general vegetation types found in the Project Area: grasslands, sagebrush, pinyon-juniper, mountain shrub, Gambel oak, ponderosa pine, mixed conifer, aspen, and riparian. Many of these vegetation types occur in mosaics, depending on slope, aspect, soil type, and other physical parameters. Distinct boundaries are rarely found between these types. For example, areas dominated by Gambel oak make up the Gambel oak vegetation type. However, Gambel oak also occurs as a non-dominant component of the mountain shrub, pinyon-juniper, and ponderosa pine vegetation types. Three additional land cover types — agriculture, barren, and water — are also found in the Project Area.

Each of these vegetation and land cover types is described in the following sections and is shown on Figure 3–33. The extent of each vegetation and land cover type within the Project Area is presented in Table 3-48. Seral stages and old growth are discussed in Sections 3.8.2.4 and 3.8.2.8.

Table 3-48 Distribution of Existing Vegetation Types in the Project Area

	Areal Extent					
Vegetation Type	NFS Land (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Portion of the Project Area (percent)
Grasslands	3,188	640	778	8,152	12,758	10.2
Sagebrush	1,353	1,168	382	9,108	12,012	9.6
Pinyon-Juniper	9,637	1,822	1,132	13,303	25,895	20.7
Mountain Shrub	437	289	290	1,650	2,666	2.1
Gambel Oak	9,698	653	691	7,877	18,919	15.1
Ponderosa Pine	19,388	1,700	1,041	12,564	34,693	27.7
Mixed Conifer	4,348	18	52	150	4,568	3.6
Aspen	1,249	4	4	55	1,313	1.0
Riparian/Wetlands	26	7	6	641	679	0.5
Agriculture	0	0	0	9,343	9,343	7.5
Barren	78	369	84	1,789	2,320	1.9
Water	2	0	1	180	183	0.1
Total	49,404	6,671	4,462	64,812	125,348	100.0

Source: FS and BLM 2003

3.8.2.2.1 Grasslands

This vegetation type includes all dry and mesic areas that are dominated by herbaceous species outside of riparian areas and wetlands. Grasslands occur in scattered areas of fine-grained or deep soils with low to moderate slopes, primarily in the western two-thirds of the Project Area. Common species found in grasslands include blue grama (*Bouteloua gracilis*), squirrel-tail (*Elymus elymoides*), galleta (*Hilaria jamesii*), basin wild-rye (*Leymus cinereus*), salina wild-rye (*Leymus salinus*), Indian ricegrass (*Oryzopsis hymenoides*), western wheatgrass (*Pascopyrum smithii*), alkali sacaton (*Sporobolus airoides*), and needle-and-thread (*Stipa*

comata). Various shrubs can also occur in grasslands, although at lower densities than in shrublands. Common shrub species include four-wing saltbush (*Atriplex canescens*), shadscale (*Atriplex confertifolia*), rabbitbrush (*Chrysothamnus nauseosus*), and snakeweed (*Gutierrezia sarothrae*).

Mountain meadows are also part of this vegetation type and occur as small, isolated patches in areas of low slope at higher elevations. Mountain meadows are found only in the eastern one-third of the Project Area and cover 6 acres. Soils typically are shallow to deep, fine-grained, and can be moist or dry, depending on local conditions. Common species found in the mountain meadow community include yarrow (*Achillea lanulosa*), fringed sage (*Artemisia frigida*), elk sedge (*Carex geyeri*), Arizona fescue (*Festuca arizonica*), scarlet gilia (*Ipomopsis aggregata*), prairie junegrass (*Koelaria macrantha*), mountain muhly (*Muhlenbergia montana*), and muttongrass (*Poa fendleriana*).

3.8.2.2.2 Sagebrush

Sagebrush shrublands are often associated with grasslands and pinyon-juniper woodlands, primarily in the western two-thirds of the Project Area and along the Piedra River valley on the eastern end of the Project Area. Soils in areas of sagebrush shrublands are typically deep and moderately fine-grained to sandy. Areas of finer soils often support a sagebrush-grass mix, whereas sagebrush intergrades with pinyon-juniper in areas of thinner, rockier soil. This vegetation type is dominated by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*) mixed with other shrub species, such as bitterbrush (*Purshia tridentata*), four-wing saltbush, rabbitbrush, and snakeweed. Grass species are more common in areas of sagebrush-grass mix, while the understory is often more sparse in areas of pure sagebrush. Other common plant species in sagebrush shrublands include blue grama, side-oats grama (*Bouteloua curtipendula*), squirrel-tail, galleta, basin wild-rye, Indian ricegrass, western wheatgrass, Sandberg bluegrass (*Poa secunda*), and sand dropseed (*Sporobolus cryptandrus*).

3.8.2.2.3 Pinyon-Juniper

Pinyon-juniper is the second most common vegetation type in the Project Area (Table 3-48), occurring throughout the area at middle elevations. Soils in areas of pinyon-juniper are typically shallow and vary from stony and coarse to clay. Utah juniper (*Juniperus osteosperma*) is slightly more tolerant of hot, dry conditions and is often found at the lower elevations of this vegetation type, while pinyon pine (*Pinus edulis*) becomes more dominant at the upper elevations. Several other vegetation types, including sagebrush, Gambel oak (*Quercus gambelii*), and mountain shrublands, may be adjacent to pinyon-juniper. Older and denser stands of pinyon-juniper often contain little understory, while younger stands often support a mix of trees, shrubs, and grasses. Common species within this vegetation type include juniper, pinyon pine, basin big sagebrush, bitterbrush, serviceberry (*Amelanchier utahensis*), mountain mahogany (*Cercocarpus montanus*), blue grama, side-oats grama, galleta, Indian ricegrass, western wheatgrass, muttongrass, and needle-and-thread.

3.8.2.2.4 Mountain Shrub

The mountain shrub vegetation type is relatively limited in extent in the Project Area; however, the shrub species that define this type often occur in other vegeta-

tion types but are not dominant. This vegetation is often adjacent to the pinyon-juniper and Gambel oak types. Pure stands of mountain shrub are most common on steeper, south-facing slopes of hogbacks in the northwest part of the Project Area. Mountain shrublands occur in a variety of sites, ranging from shallow, rocky soils dominated by mountain mahogany, to deeper, moister soils dominated by Gambel oak. Common species in this vegetation type include mountain mahogany, serviceberry, basin big sagebrush, bitterbrush, Gambel oak, skunkbush sumac (*Rhus trilobata*), snowberry (*Symphoricarpos rotundifolius*), chokecherry (*Prunus virginiana*), blue grama, elk sedge, galleta, junegrass, western wheatgrass, muttongrass, Sandberg bluegrass, and needle-and-thread.

3.8.2.2.5 Gambel Oak

After ponderosa pine and pinyon-juniper, Gambel oak is the third most common vegetation type in the Project Area (Table 3-48). This type is particularly well developed on slopes on the eastern third of the Project Area, although it occurs elsewhere in smaller stands within pinyon-juniper woodlands, mountain shrublands, and ponderosa pine (*Pinus ponderosa*) forest. Gambel oak tends to mix with ponderosa pine at upper elevations. Gambel oak can be a substantial, but non-dominant, component of both the pinyon-juniper and ponderosa pine vegetation types. It also occurs to varying degrees in the mountain shrub vegetation type. The understory of dense stands of Gambel oak is often sparse because of the shading effect of the trees, although more open stands support a variety of shrubs, grasses, and forbs. Common species in the Gambel oak vegetation type include Gambel oak, serviceberry, mountain mahogany, chokecherry, skunkbush sumac, Wood's rose (*Rosa woodsii*), snowberry, elk sedge, slender wheatgrass (*Elymus trachycaulus*), prairie junegrass, and mountain muhly.

3.8.2.2.6 Ponderosa Pine

Ponderosa pine is the most common vegetation type in the Project Area (Table 3-48). It occurs at middle elevations in relatively large stands that mix extensively with the Gambel oak vegetation type. It is most common on the northern half of the western two-thirds of the Project Area (Figure 3–33). It is also commonly found in the eastern third of the Project Area, where it mixes with Douglas-fir (*Pseudotsuga menziesii*) and aspen (*Populus tremuloides*) at higher elevations, on north slopes, and in areas with moister and deeper soils. Depending on the fertility of soil and the availability of moisture, ponderosa pine can form open, savanna-like stands with an abundant herbaceous understory or more dense, forest-like stands. Fire exclusion over the last century has allowed pine stands to develop with unnaturally large numbers of sapling to pole-sized trees. Ponderosa pine is the dominant species in this vegetation type, although Gambel oak often forms a substantial part of many stands. In addition, Rocky Mountain juniper often occurs mixed with pine. The understory may be composed of a diverse species mix, including kinnikinnick (*Arctostaphylos uva-ursi*), mountain mahogany, common juniper (*Juniperus communis*), Oregon grape (*Mahonia repens*), bitterbrush, buckbrush (*Ceanothus fendleri*), pine dropseed (*Blepharoneuron tricholepis*), elk sedge, junegrass, and mountain muhly. The old growth forests that occur within this type are described in Section 3.8.2.8.

3.8.2.2.7 Mixed Conifer

This vegetation type is diverse and may contain the following species: Douglas-fir, white fir (*Abies concolor*), ponderosa pine, Engelmann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and aspen. Mixed conifer occurs at higher elevations in the eastern third of the Project Area, typically on north-facing slopes. The overstory in these stands is often dense. At the low edge in elevation for mixed conifer, ponderosa pine often mixes with Douglas-fir. There are isolated patches of Engelmann spruce and subalpine fir in higher mountain ranges in the Project Area. Common plant species in the mixed conifer vegetation type include white fir, subalpine fir, common juniper, Oregon grape, Engelmann spruce, Douglas-fir, wax current, Wood's rose, heart-leaf arnica (*Arnica cordifolia*), nodding brome (*Bromus porteri*), elk sedge, Arizona fescue, junegrass, and mountain muhly.

3.8.2.2.8 Aspen

The aspen vegetation type occurs as small, isolated patches at higher elevations, primarily in the eastern third of the Project Area (Figure 3–33). Aspen also occurs as a component of the ponderosa pine and mixed conifer vegetation types. Aspen stands typically develop on moist, deep soils, are early seral in nature, and are eventually replaced by conifer species in the absence of disturbance. Common species in the aspen vegetation type include Saskatoon serviceberry (*Amelanchier alnifolia*), common juniper, Oregon grape, chokecherry, common gooseberry, Wood's rose, snowberry, heart-leaf arnica, nodding brome, elk sedge, blue wild-rye (*Elymus glaucus*), slender wheatgrass, Thurber's fescue (*Festuca thurberi*), Richardson's geranium (*Geranium richardsonii*), and Fendler's meadow-rue (*Thalictrum fendleri*).

3.8.2.2.9 Riparian/Wetlands

The riparian/wetlands type typically occurs as narrow bands of vegetation adapted to growing in frequently wet or saturated conditions. Riparian areas "develop in transitional zones between permanently saturated wetlands and upland areas. These areas exhibit vegetation or physical characteristics reflective of permanent surface or subsurface water influence" (Leonard et al. 1992). The characteristics of distinct vegetation and soil contribute to high species diversity and productivity. Continuous interactions occur among riparian, aquatic, and upland terrestrial communities through the exchange of energy and nutrients. The vegetation that visually defines a riparian area is valuable in retaining sediment, attenuating flood flows, stabilizing stream banks, removing and transforming nutrients, increasing forage production for livestock and wildlife (relative to uplands), and promoting habitat diversity for terrestrial wildlife.

Riparian areas occasionally form along intermittent streams and unlined or leaky irrigation ditches, although in these cases they rarely provide the functions and values of natural riparian ecosystems. Vegetation in riparian areas often consists of a mosaic of herbaceous wet meadows with an overstory of shrubs or trees, depending on the frequency and intensity of disturbances, such as large flood events. Common riparian species include boxelder (*Acer negundo*), alder (*Alnus incana* ssp. *tenuifolia*), narrow-leaf cottonwood (*Populus angustifolia*), Fremont cottonwood (*Populus deltoides*), quaking aspen, sandbar willow (*Salix exigua*),

wax current, common spike-rush (*Eleocharis palustris*), foxtail barley (*Hordeum jubatum*), and arctic rush (*Juncus arcticus*).

Wetlands are also included in this vegetation type. Wetlands are landscape features that are delineated based on specific soil, vegetation, and hydrologic conditions. A wetland is defined as "an area typically flooded or saturated with sufficient frequency and/or duration, with surface water or groundwater, that these areas support mostly vegetation adapted for growth in soils that are saturated under normal circumstances" (40 CFR 230). Although riparian areas often contain wetlands, they may also contain areas that do not meet the definition of wetlands. Likewise, not all wetland areas are associated with riparian communities.

Wetlands occur in a variety of forms within the Project Area. Riverine wetlands, defined by their close association with perennial streams, occur along stream channels and are often associated with riparian areas. These areas are also supported by groundwater drainage associated with floodplains and by periodic flooding events. Riverine wetlands are divided into categories based on the nature of the adjacent stream (for example, upper perennial or intermittent). Riverine wetlands can be further divided based on the dominant plant life form or the physiography and composition of the substrate (for example, unconsolidated bottom, unconsolidated shore, or streambed) and the seasonal water regime (for example, permanently flooded, semipermanently flooded, seasonally flooded, or temporarily flooded) (Cowardin et al. 1979).

Topographical depressions or other areas that are naturally sub-irrigated support palustrine wetlands, which are commonly referred to as wet meadows, and are occupied by a variety of lush plant life. These wetlands are often associated with riparian meadows and occur directly upslope from riverine wetlands. Palustrine wetlands can be further divided based on the dominant plant life form or the physiography and composition of the substrate (for example, aquatic bed, emergent, forested, scrub-shrub, unconsolidated bottom, or unconsolidated shore) and the seasonal water regime (for example, intermittently exposed, semipermanently flooded, seasonally flooded, saturated, or temporarily flooded) (Cowardin et al. 1979). Typical plant species that occur in wetlands include the same set found in riparian areas, with the addition of more typical wetland species, such as water sedge (*Carex aquatilis*), woolly sedge (*Carex lanuginosa*), hard-stem bulrush (*Scirpus acutus*), three-square bulrush (*Scirpus pungens*), and broad-leaf cattail (*Typha latifolia*).

3.8.2.2.10 Agriculture

Agricultural lands are most common in the western two-thirds of the Project Area (Figure 3–33). This land cover type includes irrigated and non-irrigated croplands, pasturelands, hay fields, and orchards. Agricultural fields have been cleared from areas that were formerly occupied by grasslands, sagebrush shrublands, and pinyon-juniper woodlands, generally where relatively deep soils have developed on low slopes. The floodplains of the Florida and Pine Rivers are also used for agriculture. Alfalfa and various grasses are the crops most commonly grown and are used for both pasture and hay. Other crops grown in the Project Area include grains, corn, and beans. In addition to planted crops, various weedy species, including noxious weeds, are often present in agricultural areas.

3.8.2.2.11 Barren

Barren areas are made up of a diverse group of non-vegetated areas, including urban lands, exposed rock, talus slopes, roads, oil and gas facilities, and other areas that lack vegetation cover. Any vegetation that occurs in these areas is sparse and often weedy. Noxious weeds are often present when disturbance is human-caused, such as around residential or industrial areas and along roads.

3.8.2.2.12 Water

Large areas of open water are rare in the Project Area, but a few small lakes and ponds account for this land cover type. These areas are often surrounded by wetlands or riparian vegetation.

3.8.2.3 Vegetation Disturbance and CBM Development

3.8.2.3.1 Concerns

Vegetation is removed during construction of roads, well pads, and other supporting facilities. Desirable native species and vegetation types may be disturbed or removed, reducing vegetative productivity and the value of the vegetation for other resource uses, such as livestock grazing or wildlife habitat.

3.8.2.3.2 Effects of CBM Development to Date

Vegetation types have been altered by past CBM development in the Project Area. In some cases, vegetation has been entirely removed; in other cases, it has been degraded through loss of some species or introduction of noxious weeds. The extent of existing impacts attributable to past CBM development is shown in Table 3-49. In addition to CBM development, agricultural, residential, and other land uses have altered native vegetation. Native vegetation has been removed by conversion to other land uses or has been degraded by loss of species and introduction of non-native species, including noxious weeds. Some of these alterations are reflected in the current amount of area in the vegetation types in Section 3.8.2.2 and Table 3-48, particularly in the agriculture and barren land cover types. Many of the impacts identified in the barren type are likely the result of past impacts to other vegetation types that were barren when the vegetation was classified.

Vegetation impacts have been concentrated in the lower elevations and on private lands where the predominant vegetation is sagebrush shrublands and grasslands, as reflected in Table 3-49. The public lands, on the other hand, have seen less development. This lesser amount of development is reflected in vegetation types that are dominant on these lands, such as mixed conifer and aspen.

3.8.2.4 Habitat Structural Stages and CBM Development

3.8.2.4.1 Baseline

The vegetation types in the Project Area provide a wide range of habitats for many wildlife species. Key habitat types in the Project Area include grasslands, sagebrush shrublands, pinyon-juniper woodlands, Gambel oak woodlands, ponderosa pine forests, and mixed conifer forests. Habitat structural stages (HSSs) are based on the classification of both size and density of vegetation present.

They are expressed as a combination of number and letter. The number represents vegetation (size 1 is grass/forb, 2 is shrub/seedling, 3 is sapling/pole, 4 is mature/overmature, and 5 is overmature/declining), and the letter represents density (A is less than 40 percent crown cover, B is 40 to 70 percent crown cover, and C is greater than 70 percent crown cover). Non-timber HSSs in the Project Area include 1M (natural meadow), 1T (areas that are potentially timbered but currently in an early seral structural stage dominated by grasses, for example, recent timber harvest units), 2S (natural shrubland), and 2T (areas that are potentially timbered but currently in an early seral structural stage dominated by shrubs, for example, old burned areas). Timbered HSSs include 3A, 3B, 3C, 4A, 4B, 4C, and 5, representing the diversity of types of timber stands present. Table 3-50 presents the extent of each HSS for each vegetation type that is present on NFS and BLM lands in the Project Area.

Table 3-49 Existing CBM Impacts to Vegetation in the Project Area

	Areal Extent					
Vegetation Type	NFS land (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	41	3	17	220	286	2.2
Sagebrush	26	3	7	175	221	1.8
Pinyon-Juniper	53	18	10	161	229	0.9
Mountain Shrub	8	8	2	10	21	0.8
Gambel Oak	72	0	4	85	162	0.9
Ponderosa Pine	197	10	8	100	310	0.9
Mixed Conifer	9	0	0	0	9	0.2
Aspen	7	0	0	0	8	0.6
Riparian/Wetlands	1	5	0	10	11	1.7
Agriculture	0	0	0	113	113	1.2
Barren	3	5	5	104	117	5.1
Water	0	0	0	1	1	0.5
Total	418	52	53	980	1,489	1.2

The HSS delineations on NFS and BLM land are based on data in the Common Vegetation Unit (CVU) database maintained by the SJNF (FS and BLM 2003). HSSs for BLM, state, and private lands were derived from the vegetation type data presented in Section 3.8.2.2. Table 3-51 shows the distribution of HSSs throughout the Project Area, including NFS, BLM, state, and private lands

Table 3-50 Distribution of Habitat Structural Stages on NFS and BLM Lands in the Project Area

Vegetation Type	Habitat Structural Stage (acres) N/a	1	2	3A	3B	3C	4A	4B	4C	5	Total
National Forest											
Grasslands	0	2,930	0	0	0	0	0	0	0	0	2,930
Sagebrush	0	0	1,358	0	0	0	0	0	0	0	1,358
Piñon-Juniper	0	0	0	2,166	4,489	0	1,741	1,249	0	0	9,645
Mountain Shrub	0	0	10,307	0	0	0	0	0	0	0	10,307
Ponderosa Pine	0	0	0	255	523	14	9,883	7,513	55	371	18,614
Mixed Conifer	0	0	0	72	818	98	470	3,026	463	0	4,982
Aspen	0	0	0	276	410	19	102	423	21	0	1,251
Riparian	51	0	3	0	0	0	0	0	0	0	54
Barren	243	0	0	0	0	0	0	0	0	0	243
Water	2	0	0	0	0	0	0	0	0	0	2
Total	296	2,930	11,665	2,769	6,240	166	12,196	12,211	539	371	49,386
BLM											
Grasslands	0	283	0	0	0	0	0	0	0	0	283
Sagebrush	0	0	197	0	0	0	0	0	0	0	197
Piñon-Juniper	0	0	2,364	0	0	0	0	0	0	0	2,364
Mountain Shrub	0	0	0	957	730	0	75	47	0	0	1,808
Ponderosa Pine	0	0	0	280	130	0	125	163	5	0	704
Mixed Conifer	0	0	0	86	8	0	0	52	0	0	146
Aspen	0	283	0	0	0	0	0	0	0	0	283
Riparian	641	0	0	0	0	0	0	0	0	0	641
Barren	527	0	0	0	0	0	0	0	0	0	527
Water	0	0	0	0	0	0	0	0	0	0	0
Total	1,168	283	2,562	1,324	868	0	200	262	5	0	6,672

Table 3-51 Distribution of Habitat Structural Stages in the Project Area

Vegetation Type	Structural Stage (acres) N/a	1	2	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	20,184	0	0	0	0	0	0	0	0	20,184
Sagebrush	0	0	5,187	0	0	0	0	0	0	0	5,187
Piñon-Juniper	0	0	0	6,181	10,984	293	2,709	1,666	0	0	21,833
Mountain Shrub	0	0	20,938	0	0	0	0	0	0	0	20,938
Ponderosa Pine	0	0	0	1,663	1,363	115	16,635	19,825	5,125	371	45,097
Mixed Conifer	0	0	0	378	895	133	477	3,589	515	0	5,987
Aspen	0	0	0	279	413	19	140	430	21	0	1,302
Riparian	3,484	0	0	0	0	0	0	0	0	0	3,484
Barren	1,186	0	0	0	0	0	0	0	0	0	1,186
Water	149	0	0	0	0	0	0	0	0	0	149
Total	4,819	20,184	26,125	8,501	13,655	560	19,961	25,510	5,661	371	125,347

CBM development directly removes vegetation and may cause loss of HSSs that are important to wildlife. A decrease in the availability of certain HSSs may detrimentally affect wildlife species that preferentially use these stages. Wildlife species that may be affected include Management Indicator Species (MIS), federally listed threatened, endangered, and candidate species, FS and BLM sensitive species, Colorado state-listed threatened, endangered, and special concern species, and other wildlife species. The SJNF utilizes specific guidelines to maintain landscape diversity, including guidelines that at least 5 percent of an area be in old growth and 5 percent in grass/forb stages. There are no corresponding diversity guidelines on BLM, state, or private lands.

3.8.2.4.2 Effects of CBM Development to Date

Table 3-52 displays the impacts of existing CBM development on HSSs on NFS and BLM lands. Table 3-53 shows the impacts of existing CBM development on HSSs throughout the Project Area, including NFS, BLM, state, and private lands. No substantial shifts have occurred in the representation of HSSs because relatively small amounts of each HSS have been affected by existing CBM development.

Table 3-52 Existing CBM Impacts to Habitat Structural Stages on NFS and BLM Lands in the Project Area

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	42	5	0	0	0	0	0	0	0	0	0	41
Sagebrush	0	0	0	26	0	0	0	0	0	0	0	0	26
Pinyon-Juniper	0	0	0	0	0	12	23	0	10	7	0	0	53
Mountain Shrub	0	0	0	8	0	0	0	0	0	0	0	0	8
Gambel Oak	0	0	0	68	5	0	0	0	0	0	0	0	72
Ponderosa Pine	0	0	0	0	0	1	3	0	85	99	0	10	197
Mixed Conifer	0	0	0	0	0	0	2	0	1	6	0	0	9
Aspen	0	0	0	0	0	2	4	0	0	1	0	0	7
Riparian	0	0	0	0	0	0	0	0	1	0	0	0	1
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	3	0	0	0	0	0	0	0	0	0	0	0	3
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	42	5	102	5	15	32	0	98	114	0	10	418
BLM (including split estate lands)													
Grasslands	0	3	0	0	0	0	0	0	0	0	0	0	3
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	13	5	0	2	0	0	0	18
Mountain Shrub	0	0	0	8	0	0	0	0	0	0	0	0	8
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	5	0	0	3	3	0	0	11
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	5	0	0	0	0	0	0	0	0	0	0	0	5
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	5	0	0	0	0	0	0	0	0	0	0	0	5
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	10	3	0	11	0	18	5	0	3	3	0	0	52

Table 3-53 Existing CBM Impacts to Habitat Structural Stages in the Project Area

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	212	74	0	0	0	0	0	0	0	0	0	286
Sagebrush	0	0	0	221	0	0	0	0	0	0	0	0	221
Pinyon-Juniper	0	0	0	0	0	52	105	0	42	30	0	0	229
Mountain Shrub	0	0	0	21	0	0	0	0	0	0	0	0	21
Gambel Oak	0	0	0	155	7	0	0	0	0	0	0	0	162
Ponderosa Pine	0	0	0	0	0	2	6	0	140	147	0	14	310
Mixed Conifer	0	0	0	0	0	0	2	0	1	6	0	0	9
Aspen	0	0	0	0	0	2	4	0	0	2	0	0	8
Riparian	0	0	0	1	0	0	0	0	10	0	0	0	11
Agriculture	113	0	0	0	0	0	0	0	0	0	0	0	113
Barren	117	0	0	0	0	0	0	0	0	0	0	0	117
Water	1	0	0	0	0	0	0	0	0	0	0	0	1
Total	232	212	74	398	7	56	117	0	194	185	0	14	1,489

3.8.2.5 Wetlands, Riparian Areas, and CBM Development

3.8.2.5.1 Baseline

Riparian areas within the Project Area are generally limited to the immediate vicinity of the larger rivers, such as the Animas, Florida, Pine, and Piedra Rivers, as well as a few of the larger streams such as Beaver Creek and Sauls Creek. The National Wetlands Inventory (NWI) has mapped wetlands in the Project Area (Figure 3–34). Small, scattered wetlands may be located throughout the Project Area that do not appear on NWI maps, and wetlands shown on NWI maps have not been verified in the field. For these reasons, NWI maps provide only an estimate of the extent and location of wetlands and cannot be used as a substitute for field-based delineations. As with riparian areas, wetlands are concentrated near the larger rivers and some perennial streams. Other wetlands are found scattered throughout the Project Area.

There are 44 point wetlands, 210 miles of linear wetlands, and 935 acres of polygonal wetlands in the Project Area. The highest percentage of point wetlands is on private land (approximately 66 percent), while smaller percentages are on NFS (30 percent) and state (4 percent) lands. There are no point wetlands on BLM lands. The highest percentage of linear wetlands is on private land (approximately 81 percent), while smaller percentages exist on NFS (13 percent), state (5 percent), and BLM (1 percent) lands. The highest percentage of polygonal wetlands is found on private land (approximately 92 percent), while smaller percentages exist on NFS (5 percent), state (2 percent), and BLM (1 percent) lands.

According to NWI maps, 36 wetland types exist within the Project Area. The two most common point wetland types are palustrine, aquatic bed, semipermanently flooded (22 wetlands); and palustrine, unconsolidated shore, seasonally flooded (16 wetlands). Both of these wetland types represent stock ponds or other small impoundments. The most common linear wetland type in the Project Area is riv-

erine, intermittent, streambed, seasonally flooded (90 miles), representing the abundance of streams that flow seasonally and support wetland vegetation along their banks. The second most common linear wetland type is palustrine, emergent, seasonally flooded (59 miles), which represents narrow strips of palustrine wetlands adjacent to riparian areas or riverine wetlands.

The most abundant polygonal wetland type is palustrine, emergent, seasonally flooded (299 acres). This and the fourth most abundant polygonal wetland — palustrine, emergent, saturated (104 acres) — represent large areas of wet meadow located in the floodplains of major streams. The second most common polygonal wetland — palustrine, aquatic bed, semipermanently flooded (165 acres) — represents areas of shallow water in lakes and reservoirs and along riparian areas that hold water for much of the year. The third most common polygonal wetland — riverine, upper perennial, unconsolidated bottom, permanently flooded (144 acres) — represents the larger perennial streams, including the Animas, Florida, Pine, and Piedra Rivers, that support wetlands along their banks.

3.8.2.5.2 Concerns

CBM development may impact wetlands and riparian areas. Existing regulations, such as Section 404 of the CWA, control the types and amounts of impacts that can occur in wetlands and riparian areas. Well pads and compressor station construction is prohibited in wetlands and riparian areas. Access roads and pipelines are constructed across wetlands and riparian areas if other routes are not available. Sediment originating from well pads, roads, pipelines, and compressor stations located in uplands can move down into wetlands and riparian areas.

Furthermore, wetlands and riparian areas may be affected by activities that impact the amount of surface water and groundwater. Dewatering of the coal bed formations can reduce surface water flow in streams, springs, and seeps. The hydraulic relationship between streams and the Fruitland Formation aquifer may be reversed by intercepting groundwater that would normally discharge to streams. The amount of water produced could exceed the recharge rate and may cause surface water to drain into the Fruitland Formation (Cox et al. 2001). Wetlands, seeps, and springs that occur on or near the outcrop of the Fruitland Formation have the greatest risk of sustaining direct impacts because of CBM-related groundwater depletions and subsequent depletions of surface water.

3.8.2.5.3 Effects of CBM Development to Date

Specific CBM development impacts to wetlands and riparian vegetation have not been identified. Existing development, particularly on state and private lands in the western two-thirds of the Project Area, has probably resulted in minor impacts to wetlands and riparian areas; however, the extent of these impacts has not been documented. Groundwater depletions and reduced groundwater discharges to surface drainages that have resulted from dewatering of the Fruitland Formation have affected the quantity of surface flows. To date, approximately 65 acre-feet/year are depleted from surface flows because of reduced groundwater discharge (Cox et al. 2001). Surface flows depletion have the potential to affect wetland and riparian areas by reducing the amount of water available to support

vegetation; however, the reduction is negligible in relation to the amount of surface water flows, and no impacts have been documented to date.

3.8.2.6 Vegetation Restoration and CBM Development

3.8.2.6.1 Concerns

Vegetation restoration is an important component of CBM development. Interim restoration of the portion of the impacted area that is not needed for production takes place after construction is complete. Once a well is abandoned, the entire impacted area is restored. Restored areas often differ from undisturbed areas in terms of the plant species present and the ecological function of the restored community. Restored areas where species composition and cover are altered may not serve ecosystem functions currently served by undisturbed vegetative communities. Vegetation communities slowly return to pre-construction conditions, particularly where shrubs or trees dominate the pre-disturbance community. The introduction of noxious weeds (as discussed in Section 3.8.2.7) can slow restoration because weeds compete with desirable species for water and nutrients. Harsh environmental conditions, such as drought and poor soils, may also make restoration difficult to achieve (Bell 2002b).

3.8.2.6.2 Effects of CBM Development to Date

Limited information is available on vegetation restoration success at existing CBM wells in the Project Area. Interim reclamation has generally been successful for the few producing wells where restoration has been monitored on NFS lands. During interim reclamation, the part of the well site to remain in use is covered with gravel to prevent erosion, and the remaining area is restored. Of two plugged and abandoned wells that have been monitored, final restoration has been successful at one site, but additional work is needed at the other to ensure success (Bell 2002b).

Areas impacted by road construction adjacent to the road surface are also subject to interim reclamation. Interim reclamation along roads has generally been successful. However, noxious weeds have been introduced in some locations, as discussed in Section 3.8.2.7. Noxious weeds are controlled through a cooperative agreement between the BLM/FS and CBM development companies. Control has generally been successful and, as a result, noxious weeds have not been a substantial problem in restoration. Instead, most cases of unsuccessful restoration are the result of harsh environmental conditions such as limited availability of water, low soil fertility, or a south-facing aspect (Bell 2002b).

3.8.2.7 Noxious Weeds and CBM Development

3.8.2.7.1 Baseline

A noxious weed is defined by the Colorado Weed Management Act as "an alien plant or parts of an alien plant that have been designated by rule as being noxious or has been declared a noxious weed by a local advisory board, and meets one or more of the following criteria: a) aggressively invades or is detrimental to economic crops or native plant communities; b) is poisonous to livestock; c) is a carrier of detrimental insects, diseases, or parasites; or d) the direct or indirect effect of the presence of this plant is detrimental to the environmentally sound management of natural or agricultural ecosystems" (Colorado Revised Statutes [CRS]

2000). Appendix G lists noxious weeds of concern for the State of Colorado, Archuleta County, and La Plata County.

Noxious weeds occur throughout the Project Area (Cook 2002a, Ratliff 2002). La Plata County weed maps indicate the presence of the following noxious weeds within the La Plata County portion of the Project Area: musk thistle (*Carduus nutans*), spotted knapweed (*Centaurea maculosa*), yellow toadflax (*Linaria vulgaris,*), Canada thistle (*Cirsium arvense*), Russian knapweed (*Centaurea repens*), and Scotch thistle (*Onopordum acanthium*) (O'Donnell 2002). Leafy spurge (*Euphorbia esula*), musk thistle, and Russian knapweed are present in the portion of the Project Area in Archuleta County (Ratliff 2002). Table 3-54 lists the distribution and extent of known noxious weed infestations in the Project Area. Throughout the western portion of the Project Area, infestations of noxious weeds are scattered throughout private lands. Infestations on NFS lands are located primarily along existing roads at lower elevations at the base of the HD Mountains. Figure 3–35 shows the location and extent of various noxious weed infestations in the Project Area.

Table 3-54 Areal Extent of Known Noxious Weed Infestations in the Project Area

	Areal Extent (acres)				
Dominant/Co-dominant Species	NFS	BLM	State	Private	Total
Canada Thistle	126	5	0	362	493
Canada Thistle/Houndstongue	0	0	0	0	0
Canada Thistle/Musk Thistle	1,061	0	1	57	1,119
Canada Thistle/Musk Thistle/Common Mullein	22	0	0	10	32
Canada Thistle/Musk Thistle/Field Bindweed	1	0	0	0	1
Canada Thistle/Musk Thistle/Houndstongue	95	0	0	53	149
Canada Thistle/Spotted Knapweed	0	0	0	18	18
Houndstongue/Musk Thistle	0	0	0	0	0
Musk Thistle	29	0	0	472	500
Musk Thistle/Canada Thistle	0	0	0	122	122
Musk Thistle/Houndstongue	0	0	0	0	0
Musk Thistle/Russian Knapweed	0	0	0	0	0
Oxeye Daisy	0	0	0	1	1
Russian Knapweed	0	0	0	37	37
Scotch Thistle	0	0	0	54	54
Spotted Knapweed	0	0	0	5	5
Spotted Knapweed/Musk Thistle	0	0	0	5	5
Whitetop	0	0	0	0	0
Yellow Toadflax	0	40	0	5	45
Total	1,334	45	1	1,201	2,581

3.8.2.7.2 Concerns

Non-native plant species have become increasingly common in the Project Area. Many of these species are opportunistic and are capable of invading the recently disturbed soil. Roads often serve as dispersal corridors between patches of disturbed ground, facilitating the spread of these species into new areas. Once they become established, non-native species can out-compete and eventually replace native species, thereby reducing forage productivity and the overall vigor of native plant communities. Because of these effects, many of these weed species are viewed as detrimental to the environment. Their occurrence, distribution, and

density are variable and influenced by many factors, including disturbance type and frequency, climatic and soil conditions, and local management efforts.

CBM development results in surface disturbance that creates an opportunity for noxious weeds and other non-native species to establish. Vehicle and heavy equipment movement from site to site during CBM development can spread weed seeds into areas that are not currently infested. Once they are established, noxious weeds are extremely difficult to eradicate and can spread into undisturbed areas.

Interim reclamation after construction and final restoration at abandonment may also contribute to non-native and noxious weed species infestation. In addition, weed seeds are sometimes unintentionally included in seed mixes for revegetation, or are brought in on vehicles. Reclamation measure, such as removal of structures, recontouring, and discing of abandoned roads, may also provide opportunity for weeds to establish. Site revegetation immediately after surface disturbance is one method for minimizing the invasion of non-native and noxious weed species by providing competition from native species. Erosion control matting or other mulching materials may also help prevent weed invasion.

3.8.2.7.3 Effects of CBM Development to Date

The Project Area is near the urban centers of La Plata County and consequently receives a high level of use that contributes to the spread of noxious weeds. Recreation, timber sales, livestock grazing, gas development, and wildlife have all contributed to the presence of noxious weeds within the Project Area. Most noxious weeds within the Project Area are non-native colonizers that readily establish in areas of disturbed ground. Inventory, monitoring, and control efforts are ongoing on NFS and BLM lands in the Project Area. Approximately 27 miles of roadside and 60 acres of weed infestations are currently monitored and treated annually on NFS and BLM lands in the Project Area (Wood 2003).

Measures CBM companies take to prevent the spread of weeds on private lands during construction and maintenance of CBM-related facilities do not appear to be adequate. Once weed infestations are established, the companies spray for control (Cook 2002b). Noxious weeds found on private land subject to CBM development are identified and treated by the county where they are located. Noxious weeds in the Project Area are found along roadsides, including CBM access roads, indicating that vehicles are one of the potential vectors for spread of these species. New CBM roads are likely to serve as a conduit for weed invasion (Cook 2002b).

3.8.2.8 Old Growth Ponderosa Pine and CBM Development

3.8.2.8.1 Baseline

The old growth assessment on NFS lands relies on data collected using three different methods: field surveys, timber inventory data, and photo interpretation (FS 2003e). The most reliable method is the actual field visit, where attributes of old growth are measured and recorded, and an old growth score is calculated. More than 42,000 acres of ponderosa pine, 39,000 acres of mixed conifer, and 68,000 acres of spruce/fir have been inventoried across the SJNF using this

method. Stand attributes collected in the field include tree age, tree diameter, number of snags, dead-topped or broken trees, rotten trees, canopy layers, and large trees per acre. An old growth score is calculated from these attributes.

The second most reliable method for inventorying old growth is to use existing timber inventory data from the stand exam. A computer program extracts the attributes listed above from stand exam data and calculates an old growth score. Approximately one-third of the SJNF has been inventoried for old growth using this method.

Stands that have not been inventoried by a field survey or by using stand exam data have been assigned old growth scores using photo interpretation. These stands were assigned an old growth score based on photo comparisons with sites that were similar in all aspects, such as slope, aspect, crown sizes and densities, and elevation, and that had been assigned a stand exam score. The stand exam score was applied to its photo-interpreted "look-alike" site. All photo-interpreted sites in the Project Area with a high score for old growth have been field-verified.

This analysis used the following definition to identify old growth sites across the SJNF:

(1) Average age of upper canopy trees 200 years or greater;
(2) Average diameter of upper canopy trees 16 inches or greater;
(3) Ten or more trees per acre that are at least 16 inches diameter at breast height (d.b.h.) or greater; and
(4) One or more rotten trees, or one or more "dead or broken top" trees per acre.

Snags are also considered an important component of old growth. They are not included in the specific query for the old growth definition, however, because of known data gaps on snag density in the stand exam data. Instead, the snag density average has been calculated from all field-visited sites with tree ages more than 200 years old. The average snag density for these ponderosa pine sites forest-wide is 3.6 per acre. The average snag density for ponderosa pine sites more than 200 years old in the analysis area is 2.2 per acre.

A total of 746 acres of old growth ponderosa pine stands have been recorded on NFS lands in the Project Area (Figure 3–36). These stands represent 3.8 percent of the total area of ponderosa pine on NFS lands in the Project Area (19,388 acres) and are located primarily in the southeastern portion of the Project Area, in the Spring Creek, Ignacio Creek, and other nearby watersheds. Forest-wide, there are 260,941 acres of ponderosa pine, of which 15,245 acres (5.8 percent) are old growth. Similar data have not been collected for BLM, State, or private lands in the Project Area, though the acreage of old growth pine is suspected to be lower on these other jurisdictions.

3.8.2.8.2 Concerns

Stands of old growth ponderosa pine are an important biological resource for several reasons. First, the structure of these stands is typically more diverse, both

horizontally and vertically. Trees of various ages and densities occur throughout the stand. Second, the understory is also typically more diverse than that of younger, more homogenous stands. Third, old growth trees and stands contain tremendous genetic diversity, having survived and adapted to many droughts and other small climatic changes (Kaufmann, 2003). Finally, old growth stands provide important habitat for a number of wildlife species, including FS sensitive and management indicator species, such as the northern goshawk, woodpeckers, and migratory songbirds. Old growth forests also provide habitat to a variety of species with small home ranges or poor dispersal capacity, including lichens (Enns 1998).

Old growth ponderosa pine is relatively uncommon across the Project Area and the SJNF. This lack of landscape abundance is primarily the result of timber harvesting that removed the largest and oldest ponderosa pine trees from many stands. Tree ages measured in the old growth stands in the Project Area range from 200 to more than 435 years. Of the 12,061 stands surveyed for old growth across the SJNF, seven have trees over 400 years old (FS 2003e). Ponderosa pine trees typically remain dominant in these stands after timber harvest. However, the structure of old growth is altered, and some of the attributes of the habitat that make these areas important to wildlife are lost.

3.8.2.8.3 Effects of CBM Development to Date

One road that is used to access CBM wells, NFSR 615, has impacted an old growth stand of ponderosa pine. This road was constructed before CBM development to access timber stands and private land in-holdings. A CBM well pad and short segment of unnumbered road on the southern edge of the Project Area were also constructed in an old growth stand of ponderosa pine. Collectively, these impacts have caused the loss of 10 acres of ponderosa pine old growth.

3.8.2.9 Ecological Processes and CBM Development

3.8.2.9.1 Baseline

Two ecological processes that may be affected by CBM development include fire regimes and insect and disease infestations in timber stands. The current fire management direction for federal lands in the Project Area allows for management, rather than immediate suppression, of natural (lightning-caused) fires when they will benefit the ecological health of the area. The Turkey Creek Fire (July 1997) is a recent example of a Project Area fire allowed to burn for resource benefit.

Another component of fire management is fuels reduction projects. Four fuels reduction projects have recently been planned or completed on NFS lands in the Project Area:

- The Deer Valley thinning and mowing project in the northwestern portion of NFS lands in the Project Area.
- The Lange Canyon prescribed burn in the northern and northeastern portions of NFS lands in the Project Area.
- The Bull Canyon prescribed burn in the southeastern portion of NFS lands in the Project Area.

- The HD Fuels hydro mowing project in the western and southwestern portion of NFS lands in the Project Area.

Several environmental factors, including drought and historical wildfire control, have led to *Ips* beetle, other insect, and black stain disease impacts. These insect and disease infestations have reached epidemic levels on all jurisdictions within the Project Area. The current outbreak has affected pinyon pine and, to a lesser extent, ponderosa pine in the Project Area. The outbreak has not yet reached a peak, meaning a larger number of trees in the Project Area could be affected, depending primarily on weather and secondarily on other factors such as predatory response from increased woodpecker populations.

The nearby Missionary Ridge Fire could worsen the insect outbreak by creating more dead and dying trees that would provide potential brood sites for *Ips* beetles and other insects. In addition, turpines (scent) that are released when pines are cut may attract beetles to surrounding areas. The beetles, which winter in many of the dead trees, are expected to emerge in early- to mid-May and spread into nearby healthy trees.

3.8.2.9.2 Concerns

CBM development can affect fire and fire management in the Project Area by changing the historical role of fire. Proposed CBM development in the Project Area could conflict with current management direction on the National Forest portion of the Project Area that allows natural fire to burn in portions of the HD Mountains, to fulfill natural disturbance regimes.

Another conflict could occur when prescribed fire projects are ignited near CBM wells. There would be concern and pressure to protect these facilities from managed fires, adding cost and complexity to the project. At some times, conditions are too dry to allow naturally occurring fires to be managed for resource benefit, and the fire management strategy turns to full suppression. In these cases, roads associated with CBM development could provide quicker access to the fire and serve as fire breaks in the natural vegetation. In this case, the proposed road system would provide a benefit to fire management. In addition, the proposed road system would provide more opportunities for implementing and managing prescribed fires.

CBM development can contribute to the insect epidemic because trees and brush would be cut and stored temporarily during construction of facilities such as roads, pads, and pipelines. The trees and brush removed during construction must be handled properly so that they do not attract or provide brood sites for insects.

3.8.2.9.3 Effects of CBM Development to Date

There is no documentation of CBM development having affected the ecological influences of fire, insects, and disease. The presence of CBM wells and other facilities is considered when wildland fires are reported nearby. These facilities are one of many factors used to select the appropriate management response to each wildland fire.

The overwhelming influence of the recent drought and other factors has obscured any potential effect of CBM development on outbreaks of insect and disease. As the number of wells, roads, and other facilities increases in the future, the possible effect of CBM development on these outbreaks may become more apparent.

3.8.2.10 Federally Listed Threatened and Endangered Plant Species

3.8.2.10.1 Baseline

Three species were evaluated because they may be affected by the proposed action or because habitat for these species may occur in the Project Area. Two of these species, Mancos milkvetch (*Astragalus humillimus*), and Mesa Verde cactus (*Sclerocactus mesae-verdae*), are not expected to occupy the area because the Project Area is either outside of their range or does not contain potential habitat for them. These two species would not be affected by the proposed project, and a "no effect" determination is appropriate. These species have been eliminated from further detailed evaluation (Appendix H).

The remaining endangered plant, Knowlton's cactus, may occur in the Project Area based on the presence of suitable habitat for this species. Table 3-55 summarizes the species general habitat, potential for occurrence in the Project Area, and any known existing impacts that have occurred to this species because of past and on-going CBM development.

Table 3-55 Federally Listed Threatened, Endangered, or Proposed Species of Plants

Species Name	General Habitat	Potential for Occurrence in the Project Area	Effects of CBM to Date
Knowlton's Cactus (*Pediocactus knowltonii*)	Alluvial deposits that form rolling gravelly hills covered with pinyon-juniper and sagebrush at 6,400 feet; occurs in La Plata County, near the Pine River, 5 miles south of the Project Area.	No known occurrences in the Project Area. Potential habitats, which may contain undocumented occurrences, exist in the Project Area. The extent of potential habitat is unknown.	No CBM-related effects to the known occurrence, which is located approximately 5 miles south of the Project Area, have been documented.

3.8.2.10.2 Concerns

Well pad, pipeline, and road construction removes vegetation and soils. This disturbance, in turn, can cause direct mortality to individual plants, and the alteration of characteristics of the vegetation around the plants can also cause increased mortality and decreased reproduction. Degradation of habitat can prevent dispersal and establishment of individual plants.

Increased access to areas that contain rare plants, including Knowlton's cactus, can lead to an increase in collection, particularly for showy species or those of particular horticultural interest (such as cacti). Furthermore, some species can be difficult to identify outside of the flowering period. CBM development may cause loss of individuals or populations if clearance surveys are not conducted during the appropriate period.

Noxious weed invasion after ground disturbance can also affect sensitive, rare, and endangered plant species. As discussed in Section 3.8.2.7, noxious weeds can out-compete and potentially replace native plants, including sensitive, rare, and endangered species. Reproductive success and establishment of new plants can also be reduced. Finally, noxious weed control programs can inadvertently cause mortality of sensitive, rare, and endangered plants.

3.8.2.10.3 Effects of CBM Development to Date

No CBM-related effects to Knowlton's cactus have been documented (Table 3-55).

3.8.2.11 Forest Service Sensitive Plant Species

3.8.2.11.1 Baseline

All FS sensitive species listed as occurring or potentially occurring on the SJNF (FS 2001d) were evaluated for potential to occur in the Project Area. A number of these species are not expected to occupy the area because the Project Area either is outside of their range or does not contain any potential habitat. Species eliminated from further detailed evaluation include: southern maidenhair fern (*Adiantum capillus-veneris*), reflected moonwort (*Botrychium echo*), pale moonwort (*Botrychium pallidum*), Altai cotton-grass (*Eriophorum altaicum* var. *neogaeum*), and Colorado tansy-aster (*Machaeranthera coloradoensis*). This group of species would not be affected by the proposed project, and a "no impact" determination is appropriate.

The remaining FS sensitive plants may occur in the Project Area, either because there are known occurrences of the species, or there is suitable habitat present for these species. Table 3-56 summarizes the general habitat, the potential for occurrence in the Project Area, and any known existing effects to these species caused by past and on-going CBM development. Appendix I presents general information about the species, including their status, distribution, life history, and factors of concern.

3.8.2.11.2 Concerns

Concerns for these and other special status plant species are discussed in Section 3.8.2.10.2.

3.8.2.11.3 Effects of CBM Development to Date

No CBM-related effects to any of the FS sensitive species of plants have been documented (Table 3-56).

3.8.2.12 Bureau of Land Management Sensitive Plant Species

3.8.2.12.1 Baseline

All BLM sensitive plant species known to occur within the area administered by the San Juan Field Office were evaluated for their potential to occur in the Project Area. A number of these species are not expected to occur because the Project Area either is outside of their range or does not contain any potential habitat. The following species have been eliminated from detailed evaluation: Cronquist

milk-vetch (*Astragalus cronquistii*), Naturita milk-vetch (*Astragalus naturitensis*), kachina daisy (*Erigeron kachinensis*), and Comb Wash buckwheat (*Eriogonum clavellatum*).

Two BLM sensitive plant species, Pagosa skyrocket and Pagosa bladderpod, may occur in the Project Area based either on known occurrences of the species or the presence of suitable habitats for these plants. Table 3-56 summarizes their general habitats, the potential for occurrence in the Project Area, and any known, existing effects that have occurred to these species because of past and ongoing CBM development. Appendix I presents the status, distribution (including potential occurrence), life history (including general habitat), and factors of concern (including existing effects from past and ongoing CBM development) for each of these species.

3.8.2.12.2 Concerns

Concerns for these and other special status plant species are discussed in Section 3.8.2.10.2.

3.8.2.12.3 Effects of CBM Development to Date

No CBM-related effects to any of the BLM sensitive species of plants have been documented (Table 3-56).

3.8.3 Environmental Consequences

Well pad, compressor station, pipeline, and road construction would all clear vegetation from impacted sites. Subsequently, portions of these facilities would be reclaimed within 1 to 3 years following construction. Interim reclamation would establish grasses and other herbaceous species in disturbed areas and generally would not attempt to replace forested areas or shrublands where these vegetation types were present before disturbance.

The remainder of the area where vegetation is removed would be used during the construction and production phases of the project. This area would remain devoid of vegetation for the 25- to 30-year life of the project. Most roads and well pads would be reclaimed during the abandonment phase of the project. After project completion, there would be some permanent loss of vegetation for roads placed on the permanent road system that are not reclaimed. The Recreation section displays the location and extent of these remaining roads and facilities which would be a small proportion of the total amount of disturbance. Final reclamation would attempt to replace forested areas and shrublands where these vegetation types were present before disturbance. Complete restoration of pre-disturbance vegetation in the structural stages that were removed would require decades.

Vegetation would be affected in several other ways. Wetlands and riparian areas are fragile vegetation types that may be crossed by roads and pipelines. Project activities have the potential to introduce and spread noxious weeds. Portions of old growth ponderosa pine stands may be removed by construction. Ecological processes, such as fire regime and insects and disease, may be altered. Finally, threatened, endangered, and sensitive plant species may be affected. The following sections discuss the specific effects to vegetation from each of these factors.

Table 3-56 FS Sensitive Species of Plants

Species Name	General Habitat	Potential for Occurrence in the Project Area	Effects of CBM to Date
Aztec Milk-vetch (*Astragalus proximus*)	Mesas, bluffs, and low hills in sandy, often alkaline clay soils in junipers or sagebrush at 5,400 to 7,300 feet; occurs in La Plata and Archuleta Counties.	Several occurrences of this species are known in the Project Area. Potential habitats, which occupy 10,090 acres, may contain undocumented occurrences.	No CBM-related effects to the known occurrences have been documented.
Giant Helleborine (*Epipactus gigantea*)	Seeps on sandstone cliffs and hillsides, and springs at 4,800 to 8,000 feet; occurs in Archuleta, 5 miles north of the Project Area, and in Chaffee, Delta, Mesa, Moffat, Montezuma, Montrose, and Saguache Counties.	No known occurrences in the Project Area. Potential habitats, which occupy 26 acres, may contain undocumented occurrences.	No CBM-related effects to the known occurrences have been documented.
Pagosa Skyrocket (*Ipomopsis polyantha* var. *polyantha*)	Fine-textured soils derived from the Mancos formation or barren shales, pinyon-juniper, ponderosa pine, or scrub oak communities, between 6,800 and 7,200 feet; endemic to the Pagosa Springs area, 10 miles east of the Project Area.	No known occurrences in the Project Area. Potential habitats, which occupy 38,800 acres, may contain undocumented occurrences.	No CBM-related effects to the known occurrences have been documented.
Pagosa Springs Bladderpod (*Lesquerella pruinosa*)	Barren areas surrounded by montane grasslands, open ponderosa pine stands with scrub oak, or Douglas fir on fine-textured soils derived from Mancos Formation shale at 6,800 to 8,300 feet; endemic to Archuleta County, in the Pagosa Springs area.	No known occurrences in the Project Area. Potential habitats, which occupy 32,668 acres, may contain undocumented occurrences.	No CBM-related effects to the known occurrences have been documented.
Large Flower Triteleia (*Triteleia grandiflora*)	Large flower triteleia occurs in grasslands, sagebrush shrublands, pinyon-juniper woodlands, and ponderosa pine forests on mesas and hills	Suitable habitat occurs in the project area	No CBM-related effects to the known occurrences have been documented
Missouri Milkvetch (*Astragalus missouriensis* var. *humistratus*)	It occurs in flat shale meadows and on shallow slopes, including roadsides and other disturbed areas. On the SJNF it has been found in a Pipo/Quga forest at 7400 ft, and in 2 dry Quga-dominated sites (one at 8500 ft).	Suitable habitat occurs in the project area	No CBM-related effects to the known occurrences have been documented

3.8.3.1 Vegetation Disturbance and CBM Development

Table 3-57 through Table 3-61 show the maximum amount of each vegetation type that would be removed under each alternative. Interim reclamation would occur for a portion of this disturbance, thus reducing the acreage impacted over the long-term production phase of the project. On average, less than one percent of all vegetation types would be impacted by the alternatives. Alternative 2 would remove the largest amount of vegetation followed in descending order by Alternatives 1, 7, 6, and 5.

Table 3-57 CBM Development Impacts to Vegetation — Alternative 1

	Areal Extent of Disturbance					Portion of
Vegetation Type	NF (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Vegetation Type (percent)
Grasslands	50	3	0	10	63	0.5
Sagebrush	23	0	0	44	67	0.6
Pinyon-Juniper	112	13	5	86	215	0.8
Mountain Shrub	2	3	0	5	10	0.4
Gambel Oak	106	4	7	23	140	0.7
Ponderosa Pine	351	4	9	26	390	1.1
Mixed Conifer	60	0	0	0	60	0.1
Aspen	15	0	0	0	15	0.1
Riparian	0	0	0	3	3	0.4
Agriculture	0	3	0	39	42	0.5
Barren	3	0	1	5	10	0.4
Water	0	0	0	0	0	0.0
Total	722	31	22	241	1,016	0.8

The largest amounts of vegetation removal would occur in the Gambel oak, pinyon-juniper, and ponderosa pine types. These types are also among the most common on National Forest, BLM, and within the Project Area; however, the proportion of these types that would be removed is also higher than for other types. On National Forest, Alternative 1 would impact 722 acres of vegetation and on BLM, 31 acres of vegetation. Alternative 2 would have the greatest impact on vegetation followed in descending order by Alternatives 1, 7, 6, and 5. Table 3-57 through Table 3-61 show the areal extent and proportion of each vegetation type that would be impacted by the alternatives.

Table 3-58 CBM Development Impacts to Vegetation — Alternative 2

	Areal Extent of Disturbance					Portion of
Vegetation Type	NF (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Vegetation Type (percent)
Grasslands	72	3	3	50	128	1.0
Sagebrush	23	6	0	65	94	0.8
Pinyon-Juniper	207	22	5	127	361	1.4
Mountain Shrub	10	6	5	21	42	1.6
Gambel Oak	235	4	10	75	325	1.7
Ponderosa Pine	484	10	14	81	589	1.7
Mixed Conifer	80	0	0	5	85	0.1
Aspen	27	0	0	3	29	0.2
Riparian	0	0	0	3	3	0.4
Agriculture	0	3	5	63	71	0.8
Barren	7	6	1	5	20	0.8
Water	0	0	0	0	0	0.0
Total	1,145	61	42	497	1,746	1.4

Table 3-59 CBM Development Impacts to Vegetation — Alternative 5

	Areal Extent of Disturbance					Portion of
Vegetation Type	NF (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Vegetation Type (percent)
Grasslands	5	0	0	16	21	0.2
Sagebrush	2	0	0	53	55	0.5
Pinyon-Juniper	6	0	4	84	94	0.4
Mountain Shrub	0	0	0	5	5	0.2
Gambel Oak	5	0	6	18	30	0.2
Ponderosa Pine	70	0	7	29	105	0.3
Mixed Conifer	3	0	0	0	3	0.0
Aspen	0	0	0	0	0	0.0
Riparian	0	0	0	3	3	0.4
Agriculture	0	0	0	39	39	0.4
Barren	0	0	1	5	7	0.3
Water	0	0	0	0	0	0.0
Total	91	0	19	251	362	0.3

Table 3-60 CBM Development Impacts to Vegetation — Alternative 6

	Areal Extent of Disturbance					Portion of
Vegetation Type	NF (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Vegetation Type (percent)
Grasslands	35	3	0	11	49	0.4
Sagebrush	18	0	0	44	61	0.5
Pinyon-Juniper	68	13	4	89	171	0.7
Mountain Shrub	2	3	0	5	10	0.4
Gambel Oak	15	4	6	20	45	0.2
Ponderosa Pine	162	4	7	25	199	0.6
Mixed Conifer	15	0	1	0	16	0.1
Aspen	0	0	0	0	0	0.0
Riparian	0	0	0	3	3	0.4
Agriculture	0	3	0	39	42	0.4
Barren	3	0	1	6	10	0.4
Water	0	0	0	0	0	0.0
Total	318	31	20	241	607	0.5

Table 3-61 CBM Development Impacts to Vegetation — Alternative 7

	Areal Extent of Disturbance					Portion of
Vegetation Type	NF (acres)	BLM (acres)	State (acres)	Private (acres)	Total (acres)	Vegetation Type (percent)
Grasslands	50	3	0	11	64	0.5
Sagebrush	24	0	0	44	68	0.6
Pinyon-Juniper	93	13	5	88	199	0.8
Mountain Shrub	2	3	0	5	10	0.4
Gambel Oak	42	4	7	25	78	0.4
Ponderosa Pine	228	4	9	26	268	0.8
Mixed Conifer	48	0	1	0	49	0.1
Aspen	11	0	0	0	11	0.1
Riparian	0	0	0	3	3	0.4
Agriculture	0	3	0	39	42	0.4
Barren	2	0	1	6	9	0.4
Water	0	0	0	0	0	0.0
Total	500	31	23	247	800	0.6

3.8.3.2 Habitat Structural Stages

Each alternative would impact several HSSs in each vegetation type on NFS and BLM lands by removing vegetation (Table 3-62 through Table 3-66). Similar impacts would occur throughout the Project Area (Table 3-67 through Table 3-71). The alternatives would disproportionately affect certain HSSs, such as 4A and 4B ponderosa pine. Between 2 and 3 percent of the 4A and 4B ponderosa pine structural stages would be affected under Alternative 2, which would have the largest impact on these HSSs. A smaller proportion of these HSSs would be affected under the other alternatives.

Areas reclaimed after CBM development often differ substantially from undisturbed areas in terms of HSS. Reclaimed areas may not serve functions now fulfilled by undisturbed vegetation communities, particularly in the first few years, when species composition, shrub and tree cover, and other environmental factors would likely be different. Development of shrub and tree cover would require an extended period and may not be complete until decades after project facilities have been abandoned. Reclaimed areas would initially be in early seral HSSs, but would eventually develop into late seral HSSs in the absence of other disturbances.

Table 3-62 CBM Impacts to Habitat Structural Stages on NFS and BLM Lands — Alternative 1

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	43	6	0	0	0	0	0	0	0	0	0	50
Sagebrush	0	0	0	23	0	0	0	0	0	0	0	0	23
Pinyon-Juniper	0	0	0	0	0	24	65	0	15	8	0	0	112
Mountain Shrub	0	0	0	2	0	0	0	0	0	0	0	0	2
Gambel Oak	0	0	0	106	0	0	0	0	0	0	0	0	106
Ponderosa Pine	0	0	0	0	0	0	6	0	148	161	0	36	351
Mixed Conifer	0	0	0	0	0	0	7	0	7	36	11	0	60
Aspen	0	0	0	0	0	0	10	0	0	5	0	0	15
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	3	0	0	0	0	0	0	0	0	0	0	0	3
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3	43	6	131	0	24	87	1	170	210	11	36	722
BLM													
Grasslands	0	2	0	0	0	0	0	0	0	0	0	0	2
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	3	0	0	0	0	0	0	3
Mountain Shrub	0	0	0	15	0	3	0	0	0	0	0	0	18
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	2	0	0	0	0	0	0	0	0	0	0	0	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	4	0	0	0	0	0	0	0	0	0	0	0	4
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	2	0	18	0	6	0	0	0	0	0	0	31

Table 3-63 CBM Impacts to Habitat Structural Stages on NFS and BLM Lands — Alternative 2

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	66	6	0	0	0	0	0	0	0	0	0	72
Sagebrush	0	0	0	23	0	0	0	0	0	0	0	0	23
Pinyon-Juniper	0	0	0	0	0	47	96	0	34	31	0	0	207
Mountain Shrub	0	0	0	10	0	0	0	0	0	0	0	0	10
Gambel Oak	0	0	0	228	8	0	0	0	0	0	0	0	235
Ponderosa Pine	0	0	0	0	0	4	9	0	251	183	0	36	484
Mixed Conifer	0	0	0	0	0	0	11	0	18	40	11	0	80
Aspen	0	0	0	0	0	8	10	0	4	5	0	0	27
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	7	0	0	0	0	0	0	0	0	0	0	0	7
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	7	66	6	261	8	58	125	1	308	259	11	36	1,145
BLM													
Grasslands	0	5	0	0	0	0	0	0	0	0	0	0	5
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	9	3	0	0	0	0	0	12
Mountain Shrub	0	0	0	18	0	0	0	0	0	0	0	0	18
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	6	6	0	0	0	0	0	12
Mixed Conifer	0	0	0	0	0	0	0	0	0	3	0	0	3
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	4	0	0	0	0	0	0	0	0	0	0	0	4
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	4	0	0	0	0	0	0	0	0	0	0	0	4
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	8	5	0	21	0	15	9	0	0	3	0	0	61

Table 3-64 CBM Impacts to Habitat Structural Stages on NFS and BLM Lands — Alternative 5

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	0	0	0	0	0	0	0	0	0	0	0	2
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	3	0	0	0	0	0	0	3
Mountain Shrub	0	0	0	15	0	3	0	0	0	0	0	0	18
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	0	0	0	0	0	0	0	0	0	0	0	0	4
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	2	0	18	0	6	0	0	0	0	0	0	32
BLM													
Grasslands	0	0	0	0	0	0	0	0	0	0	0	0	0
Sagebrush	0	0	0	0	0	0	0	0	0	0	0	0	0
Pinyon-Juniper	0	0	0	0	0	0	0	0	0	0	0	0	0
Mountain Shrub	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	0	0	0	0	0	0	0	0	0	0	0	0	0
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3-65 CBM Impacts to Habitat Structural Stages on NFS and BLM Lands — Alternative 6

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	29	6	0	0	0	0	0	0	0	0	0	35
Sagebrush	0	0	0	18	0	0	0	0	0	0	0	0	18
Pinyon-Juniper	2	0	0	0	0	20	36	0	6	4	0	0	68
Mountain Shrub	0	0	0	2	0	0	0	0	0	0	0	0	2
Gambel Oak	0	0	0	15	0	0	0	0	0	0	0	0	15
Ponderosa Pine	4	0	0	0	0	0	7	0	46	102	0	3	162
Mixed Conifer	0	0	0	0	0	0	2	0	2	11	0	0	15
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	3	0	0	0	0	0	0	0	0	0	0	0	3
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	9	29	6	34	0	20	45	0	53	117	0	3	318
BLM													
Grasslands	0	2	0	0	0	0	0	0	0	0	0	0	2
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	3	0	0	0	0	0	0	3
Mountain Shrub	0	0	0	15	0	3	0	0	0	0	0	0	18
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	2	0	0	0	0	0	0	0	0	0	0	0	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	4	0	0	0	0	0	0	0	0	0	0	0	4
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	2	0	18	0	6	0	0	0	0	0	0	31

Table 3-66 CBM Impacts to Habitat Structural Stages on NFS and BLM Lands — Alternative 7

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
National Forest													
Grasslands	0	44	6	0	0	0	0	0	0	0	0	0	50
Sagebrush	0	0	0	24	0	0	0	0	0	0	0	0	24
Pinyon-Juniper	2	0	0	0	0	22	52	0	9	9	0	0	93
Mountain Shrub	0	0	0	2	0	0	0	0	0	0	0	0	2
Gambel Oak	0	0	0	42	0	0	0	0	0	0	0	0	42
Ponderosa Pine	2	0	0	0	0	0	6	0	82	124	0	13	228
Mixed Conifer	0	0	0	0	0	0	7	0	5	32	4	0	48
Aspen	0	0	0	0	0	0	7	0	0	3	0	0	11
Riparian	0	0	0	0	0	0	0	0	0	0	0	0	0
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	2	0	0	0	0	0	0	0	0	0	0	0	2
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	44	6	68	0	22	72	1	96	168	4	13	500
BLM													
Grasslands	0	2	0	0	0	0	0	0	0	0	0	0	2
Sagebrush	0	0	0	3	0	0	0	0	0	0	0	0	3
Pinyon-Juniper	0	0	0	0	0	3	0	0	0	0	0	0	3
Mountain Shrub	0	0	0	15	0	3	0	0	0	0	0	0	18
Gambel Oak	0	0	0	0	0	0	0	0	0	0	0	0	0
Ponderosa Pine	0	0	0	0	0	0	0	0	0	0	0	0	0
Mixed Conifer	0	0	0	0	0	0	0	0	0	0	0	0	0
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	2	0	0	0	0	0	0	0	0	0	0	0	2
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Barren	4	0	0	0	0	0	0	0	0	0	0	0	4
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	6	2	0	18	0	6	0	0	0	0	0	0	31

Table 3-67 CBM Impacts to Habitat Structural Stages in the Project Area — Alternative 1

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	53	10	0	0	0	0	0	0	0	0	0	63
Sagebrush	0	0	0	67	0	0	0	0	0	0	0	0	67
Pinyon-Juniper	0	0	0	0	0	47	113	0	34	21	0	0	215
Mountain Shrub	0	0	0	10	0	0	0	0	0	0	0	0	10
Gambel Oak	0	0	0	139	1	0	0	0	0	0	0	0	140
Ponderosa Pine	0	0	0	0	0	1	7	0	167	178	0	38	390
Mixed Conifer	0	0	0	0	0	0	7	0	7	36	11	0	60
Aspen	0	0	0	0	0	0	10	0	0	5	0	0	15
Riparian	0	0	0	0	0	0	0	0	2	0	0	0	3
Agriculture	42	0	0	0	0	0	0	0	0	0	0	0	42
Barren	10	0	0	0	0	0	0	0	0	0	0	0	10
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	52	53	10	217	1	48	136	1	210	240	11	38	1,016

Table 3-68 CBM Impacts to Habitat Structural Stages in the Project Area — Alternative 2

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	106	22	0	0	0	0	0	0	0	0	0	128
Sagebrush	0	0	0	94	0	0	0	0	0	0	0	0	94
Pinyon-Juniper	0	0	0	0	0	81	167	0	62	51	0	0	361
Mountain Shrub	0	0	0	42	0	0	0	0	0	0	0	0	42
Gambel Oak	0	0	0	315	10	0	0	0	0	0	0	0	325
Ponderosa Pine	0	0	0	0	0	5	12	0	302	228	1	40	589
Mixed Conifer	0	0	0	0	0	0	12	0	19	43	11	0	85
Aspen	0	0	0	0	0	8	11	0	4	6	0	0	29
Riparian	0	0	0	0	0	0	0	0	2	0	0	0	3
Agriculture	71	0	0	0	0	0	0	0	0	0	0	0	71
Barren	20	0	0	0	0	0	0	0	0	0	0	0	20
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	91	106	22	451	10	95	202	1	390	328	12	40	1,746

Table 3-69 CBM Impacts to Habitat Structural Stages in the Project Area — Alternative 5

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	16	4	0	0	0	0	0	0	0	0	0	21
Sagebrush	0	0	0	55	0	0	0	0	0	0	0	0	55
Pinyon-Juniper	0	0	0	0	0	21	45	0	16	13	0	0	94
Mountain Shrub	0	0	0	5	0	0	0	0	0	0	0	0	5
Gambel Oak	0	0	0	29	1	0	0	0	0	0	0	0	30
Ponderosa Pine	0	0	0	0	0	0	4	0	47	52	0	1	105
Mixed Conifer	0	0	0	0	0	0	2	0	0	1	0	0	3
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	2	0	0	0	3
Agriculture	39	0	0	0	0	0	0	0	0	0	0	0	39
Barren	7	0	0	0	0	0	0	0	0	0	0	0	7
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	46	16	4	90	1	21	51	0	65	66	0	1	362

Table 3-70 CBM Impacts to Habitat Structural Stages in the Project Area — Alternative 6

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	39	10	0	0	0	0	0	0	0	0	0	49
Sagebrush	0	0	0	61	0	0	0	0	0	0	0	0	61
Pinyon-Juniper	2	0	0	0	0	43	84	0	24	18	0	0	171
Mountain Shrub	0	0	0	10	0	0	0	0	0	0	0	0	10
Gambel Oak	0	0	0	45	1	0	0	0	0	0	0	0	45
Ponderosa Pine	4	0	0	0	0	0	8	0	64	118	0	5	199
Mixed Conifer	0	0	0	0	0	0	2	0	2	12	0	0	16
Aspen	0	0	0	0	0	0	0	0	0	0	0	0	0
Riparian	0	0	0	0	0	0	0	0	2	0	0	0	3
Agriculture	42	0	0	0	0	0	0	0	0	0	0	0	42
Barren	10	0	0	0	0	0	0	0	0	0	0	0	10
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	58	39	10	117	1	44	95	0	92	147	0	5	607

Table 3-71 CBM Impacts to Habitat Structural Stages in the Project Area — Alternative 7

	Habitat Structural Stage (acres)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0	54	10	0	0	0	0	0	0	0	0	0	64
Sagebrush	0	0	0	68	0	0	0	0	0	0	0	0	68
Pinyon-Juniper	2	0	0	0	0	46	101	0	28	22	0	0	199
Mountain Shrub	0	0	0	10	0	0	0	0	0	0	0	0	10
Gambel Oak	0	0	0	77	1	0	0	0	0	0	0	0	78
Ponderosa Pine	2	0	0	0	0	1	8	0	102	141	0	14	268
Mixed Conifer	0	0	0	0	0	0	7	0	5	32	4	0	49
Aspen	0	0	0	0	0	0	7	0	0	3	0	0	11
Riparian	0	0	0	0	0	0	0	0	2	0	0	0	3
Agriculture	42	0	0	0	0	0	0	0	0	0	0	0	42
Barren	9	0	0	0	0	0	0	0	0	0	0	0	9
Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	55	54	10	155	1	46	123	1	137	199	5	14	800

3.8.3.3 Wetlands, Riparian Areas, and CBM Development

Potential wetlands and riparian area impacts include direct loss due to road, well pad, and other facilities construction; degradation due to sediment produced from facilities; and reduction of surface water and groundwater flows resulting from dewatering the Fruitland Formation.

Loss of wetlands and riparian areas may occur despite the intention to avoid these environmentally sensitive areas where possible. Well pads and compressor stations would generally be located in upland sites where they would not directly affect wetlands and riparian areas.

Linear facilities would be constructed across intermittent streams, and would avoid perennial streams and rivers in the Project Area. Wetlands and riparian areas are most common and generally best developed along perennial streams. Wetlands and riparian areas may also develop along intermittent streams. Alternatives with larger numbers of wells and associated roads are more likely to affect wetlands and riparian areas than are alternatives with fewer wells. Table 3-72 shows the approximate number of crossings of intermittent streams for each of the alternatives.

Areas excavated for utility pipelines would be restored immediately after construction, and most roads would be restored when the project is eventually abandoned, reducing wetland sedimentation. However, some level of impact would persist indefinitely and surface disturbances and related impacts to water quality should be considered long-term effects (Chapter 3, Surface Water).

Table 3-72 Impacts Contributing to Potential Effects to Streams in the Project Area

Alternative	Disturbance[1] (acres)	New Road (miles)	Stream Crossings[2]	Rank[3]
National Forest				
1	722	90	151	2
2	1,145	145	246	1
5	91	15	28	5
6	318	39	64	3
7	500	64	121	4
BLM				
1	31	3	10	2
2	61	6	22	1
5	0	0	5	5
6	31	3	9	3
7	31	3	10	4
Project Area				
1	1,016	118	204	2
2	1,746	202	347	1
5	362	43	68	5
6	607	66	85	3
7	800	92	159	4

Notes:
1. Sedimentation risk index: a relative comparison of surface disturbances as related to sediment production.
2. "Stream Crossings" estimates new road intersections with intermittent drainages.
3. Rank of 1 = greatest risk, 5 = lowest risk.

Watershed mitigation measures (BMPs) described in Section 3.8.5, Section 3.6 (Surface Water Resources), and Section 3.5 (Soils) are designed to reduce sediment inputs to surface waters. The magnitude and duration of sediment impacts would depend on the long-term effectiveness of these sediment controls. Assuming BMPs are properly implemented, monitored, and maintained, the effects of CBM-related sedimentation to wetlands and riparian areas would be minimized.

Fill of wetlands or waters of the U.S. (which typically include non-wetland riparian areas) would be regulated through the USACE permitting process. Most impacts would be covered under current Nationwide Permits (primarily Nationwide Permits 12 and 14), although individual permits may be required for larger impacts. To date, the companies have not been required to obtain individual permits (McWhirter 2003); therefore, the types of impacts that trigger individual permits are not anticipated under any of the alternatives.

Roads may increase sedimentation and surface water flows to wetlands and riparian areas. Roads built within floodplains can redirect water, sediment, and nutrients among streams, wetlands, and riparian ecosystems to the detriment of water quality and health of the ecosystem (Trombulak and Frissell 2000). The Surface Water section of this Chapter analyzes the relationship between surface water quality and facility construction within watersheds in the Project Area. Table

3-72 shows the length of new road construction on NF and BLM lands and across the Project Area, and the areal extent of surface disturbance that are anticipated under each alternative. In general, both of these analyses show that greater potential sedimentation impacts would occur to surface water under alternatives that involve more wells and other facilities, such as Alternatives 1 and 2, and less under alternatives 5, 6, and 7.

Continued de-watering of the Fruitland Formation may reduce the availability of water in streams, seeps, and springs that support wetlands and riparian areas. However, de-watering is expected to negligibly affect surface water flows because the predicted depletions would be very minor in relation to base flows (Section 3.6). Consequently, wetlands and riparian areas that depend on surface water flows are unlikely to be affected by changes in availability of water associated with any of the alternatives. De-watering may, however, affect flows of seeps and springs located along the outcrops of the Fruitland and Pictured Cliffs Formation (Section 3.6). At these outcrop locations, pumping groundwater for CBM extraction may cause flows of seeps and springs to decrease or stop altogether, impacting riparian and wetland vegetation that depends on the seeps and springs. Similar effects to seeps and springs are predicted for each alternative (Section 3.6).

3.8.3.4 Vegetation Restoration and CBM Development

As wells reach the end of their economic lives, most facilities would be removed, and the disturbed areas would be restored and returned to pre-project uses. This analysis assumes that most new roads would be removed at abandonment; however, a residual road system would remain open for other uses.

Restoration typically includes replacing salvaged topsoil, re-grading where necessary, reseeding disturbed areas, and controlling noxious weeds. Complete restoration of some native vegetation types, particularly shrublands and forested areas, would, however, take decades because of the slow recruitment of native vegetation. Forested areas, shrublands, and even native grasslands would display lower species diversity than the pre-disturbance sites until natural recruitment re-establishes the pre-disturbance level of diversity. As a result, the ecological attributes of the native vegetation would not be restored for a period of decades to centuries in some cases. For example, old growth ponderosa pine forests would not become re-established for centuries.

Current federal land policy requires use of native plant species in restoration to the extent practicable. The priority is to allow natural revegetation where a source of seed is present, soil conditions are favorable, and noxious weeds are not expected to be a problem. Natural revegetation would not be short cut where noxious weeds may be spread and erosion must be controlled through interim and final reclamation. Where active restoration is needed, native plants from a local source are preferred. In the absence of local native plants, non-local native or preferred non-native plants may be used with certain constraints. Certified seed is required, and certain non-native aggressive or persistent species may not be used (FS 2003c). These guidelines would be followed to the extent practical.

Vegetation restoration would be required for each site under each alternative. Alternatives that involve larger amounts of ground disturbance, such as Alternatives 1 and 2, would require a greater amount of restoration. In addition, the potential for unsuccessful restoration would increase with increased development. Similarly, larger amounts of disturbance increase the potential for noxious weed species to become established and spread.

3.8.3.5 Noxious Weeds and CBM Development

Perhaps the greatest effect of CBM development on vegetation is the potential introduction and spread of noxious weeds around project facilities. Removal of native vegetation due to well pad, compressor station, and road construction would increase the potential for invasion and establishment of noxious weeds. However, the extent of these invasions is difficult to predict and would be influenced by many factors. These factors include the extent of disturbed areas, the extent of existing infestations of weeds that would provide a source of seeds, the amount of equipment moving from areas that are infested with weeds to areas that are not yet infested, the effectiveness of mitigation measures designed to prevent infestations of noxious weeds, and the time lag between the end of disturbance and successful completion of restoration.

Motor vehicles are one of the primary mechanisms for dispersal of seeds for noxious weeds. Historically, recreational vehicles (motorcycles, ATVs, and 4-wheel drive vehicles), wildlife, and livestock have been a main vector for the spread of undesirable seed. When vehicles are driven through weed-infested areas, seed may become lodged in the treads of tires or the undercarriage, or may stick to vehicles that are splattered with mud. For this reason, vehicles that traverse any portion of the Project Area would become a potential vector for further noxious weeds infestations.

Noxious weeds have the ability to displace native vegetation and hinder restoration efforts. Minimizing establishment and spread of unwanted invasive species on or near disturbed areas would therefore be of critical importance after restoration efforts have begun. Effective restoration of disturbed sites is best achieved when natural vegetative succession develops unimpeded by invasion of undesirable plant species. Desirable species, such as in a native seed mix or the pioneer species surrounding the site, are not able to compete when disturbed sites are infested with noxious weeds, thereby disrupting the successional balance necessary to restore the native plant community. The use of an approved native seed mix for restoration, as discussed in Section 3.8.3.4, would help to reduce the potential for invasion by noxious weeds.

Weed seeds may be introduced accidentally with any project activity under any alternative. The probability that noxious weeds would be introduced cannot be quantitatively predicted; however, infestations of noxious weeds have been found in association with ground disturbance from existing CBM development on federal and private lands in the Project Area. Control of existing noxious weed infestations on federal lands has generally been successful (Wood 2003), while results have been mixed on private lands (Cook 2002b). The potential for noxious weeds to establish and spread would generally be highest for alternatives that cause the greatest amount of ground disturbance, such as Alternative 2, and lowest for al-

ternatives that cause less ground disturbance, such as Alternative 5. Mitigation measures designed to prevent the introduction and spread of noxious weeds would be implemented under all alternatives; however, complete prevention and control of weeds is unlikely.

3.8.3.6 Old Growth Ponderosa Pine and CBM Development

Some old growth stands of ponderosa pine on National Forest lands in the Project Area would be impacted under Alternatives 1, 2, 6, and 7. Table 3-73 shows the number of acres and stands of old growth ponderosa pine that would be impacted by roads and well pads. No other facilities, such as compressors or disposal wells, would be constructed in old growth stands.

Table 3-73 CBM Impacts to Old Growth Ponderosa Pine by Alternative

Old Growth Ponderosa Pine	Alternative 1	2	5	6	7	Existing Resources
NFS Lands						
Acres Affected	36	36	0	3	13	746 acres
Percent of Acres Affected	5	5	0.0	0.4	2	
Stands Cumulatively Affected[1]	13	13	3	4	6	15 stands[1]
Percent of Stands Cumulatively Affected[1]	87	87	20	27	40	
Project Area						
Acres Affected	36	36	0	3	13	746 acres
Percent of Acres Affected	5	5	0.0	0.4	2	

Notes:
1. Stand data are available on NFS lands only.

Old growth stands in the HD Mountains typically occupy relatively flat areas, which capture and hold more moisture than do steep hillsides. The preferred location for well pads is also on these relatively flat sites to avoid creating steep cut banks and associated erosion. Because opportunities for avoidance are constrained by terrain features, well pad and road construction along the Pine-Piedra Stock Driveway cannot totally avoid old growth and would eliminate a number of very old and large trees, or clumps of trees (some aged 400 years+).

Depending on the ultimate location of roads and well pads and the size and shape of the stands, old growth stands may be impacted in various ways. Beyond direct removal, the functions and values of affected stands may be decreased or lost. Roads and well pads may fragment up to 80% of existing stands of old growth, increase the amount of edge, and change the physical and biological environment of the stands — the portion of the stand nearest the disturbed areas would become warmer and dryer and more light and wind would penetrate the stand. These physical effects would favor plants and wildlife that are adapted to these conditions and tend to exclude species common to the interior of the forest (Noss and Cooperrider 1994) (See also the Wildlife section of this chapter and Appendix J). These effects may continue into the stand for some distance beyond the area where vegetation is removed, up to two to three times the average tree height (Harris 1984). The entire area may become edge in small or narrow

stands, while in larger stands the amount of interior habitat can be noticeably reduced (Meffe and Carroll 1994). Fragmentation reduces the total area of the original habitat and may isolate populations dependent on the remaining patches (Crow 1990). The extent of these potential impacts would depend on the size and configuration of the impacted old growth stand and the location of the impacting structure. Steps would be taken to avoid old growth stands where terrain limitations do not create unacceptable tradeoffs.

The alternatives would directly affect from 0 to 13 of the 15 old growth stands (Table 3-73), resulting in impacts from 0 acres (Alternative 5) to 36 acres of old growth pine (Alternatives 1 and 2). Alternative 2 would result in the largest impact followed in descending order by Alternatives 1, 7, 6, and 5. This represents from 0 to 5 percent of old growth acres inventoried within the National Forest portion of the Project Area. Avoidance mitigation would be utilized during road and well pad staking to reduce the extent of this impact. However, until actual well pad locations are proposed during APD submittal, the ability to move facilities to avoid old growth impact is unknown. For some staked locations along the old stock driveway, field reviews have found that total avoidance is not possible.

Final reclamation of old growth areas, as with other tree stands, after abandonment would not replace the characteristics that were lost. Appropriate vegetation, including ponderosa pine, would be planted in areas formerly occupied by ponderosa pine forest; however, several centuries may pass before these directly impacted areas once again show substantial characteristics of old growth. Other areas that currently support mature ponderosa pine would advance into an old growth condition within a shorter timeframe, but the geographic extent of this structural and ecological representation is based on future management decisions, primarily timber harvest, that may affect ponderosa pine stands within the Project Area.

3.8.3.7 Ecological Processes and CBM Development

The alternatives may cause alteration of ecological processes, particularly fire, insects, and disease regimes. Fire regimes may change for several reasons. For example, the frequency of human-caused fire may increase because of the greater amount of activity, especially along roads, in the Project Area. Conversely, the larger road network may increase the ability of local firefighters to suppress fires, reducing the spread of fires in areas where access was previously limited. In addition, fire suppression may increase to protect CBM facilities. The potential for allowing naturally ignited fires to burn would be reduced because of the need to protect CBM facilities. Alternatives with the highest level of development and road construction, such as Alternative 1 and Alternative 2, would affect fire regimes to a greater extent than alternatives with a lower level of development, such as Alternative 5. Mitigation measures described in Section 3.8.5, such as closure of project roads to public use and a requirement that industry personnel follow all agency fire precautions, would reduce the potential for increased human-caused fires.

During the project's construction phase, cut trees and limbs would be present along roads and at well pads, and may increase infestations of the *Ips* beetle. By attracting more beetles, the surrounding trees that are not directly affected by

construction would be at greater risk of insect attack. Alternatives with the highest level of development, such as Alternatives 1 and 2, would generate more wood materials than would alternatives with a lower level of development such as Alternatives 5 and 6. Mitigation measures designed to ensure timely removal of wood from construction areas would reduce the potential for increased insect populations from CBM development (Section 3.8.5).

3.8.3.8 Federally Listed Threatened, Endangered, and Proposed Plant Species

One federally listed plant species may occur in the Project Area and may be affected by CBM development. Table 3-74 presents a summary of the direct, indirect, and cumulative effects of the project on this species, as well as a determination of effects (summarized from Appendix H).

Table 3-74 Federally Listed Threatened, Endangered, and Proposed Plant Species — All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Knowlton's Cactus	Implementation of any of the alternatives is not likely to have any direct or indirect effect on Knowlton's cactus. Pre-construction surveys would be implemented in areas of suitable habitat that would be disturbed by activities associated with any of the alternatives. In the event that any previously unknown occurrences of Knowlton's cactus are discovered during these surveys, the FWS would be consulted, and the location of the occurrence and an appropriate buffer would be avoided by all ground-disturbing activities.	Implementation of any of the alternatives is not likely to have any cumulative effect on Knowlton's cactus. Undocumented occurrences of this species may have been affected by past CBM development or other ground-disturbing activities because suitable habitats may not have been surveyed.	Implementation of the proposed action, as described above, may affect, but is not likely to adversely affect, Knowlton's cactus, based on discountable effects. This determination is based on the lack of known occurrences of this species in the Project Area, negative results from surveys in the Project Area, and the avoidance of buffer areas surrounding any population of Knowlton's cactus that are found during preconstruction surveys

3.8.3.9 FS Sensitive Plant Species

Four FS sensitive plant species may occur in the Project Area and may be affected by CBM development. Table 3-75 contains a summary of the direct, indirect, and cumulative effects of the project on these species, as well as determinations of effects. Appendix I addresses these sensitive plant effects and determinations in detail.

3.8.3.10 Bureau of Land Management Sensitive Plant Species

Two BLM sensitive plant species may occur in the Project Area and may be affected by the proposed project. These species, the Pagosa skyrocket and Pagosa Springs bladderpod, are also FS sensitive species, and are addressed in Table 3-75. Appendix I addresses these effects and determinations in detail.

Table 3-75 Forest Service Sensitive Plant Species —All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Aztec Milk-vetch	No known occurrences of this species would be disturbed. 11 to 234 acres (less than 1 to 2 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Aztec milk-vetch were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Aztec milk-vetch.	Implementation of any of the alternatives may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for the Aztec milk-vetch. This determination is based on the low likelihood that this species occurs within the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and implementation of avoidance measures if new occurrences are discovered.
Giant Helleborine	No known occurrences of this species would be disturbed. No suitable habitat for this species would be disturbed under any of the alternatives. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the giant helleborine were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible. Construction in or near suitable wetland or spring habitats may alter or interrupt the hydrologic conditions that support this species. Groundwater withdrawal associated with the project may result in decreased spring and seep flows in areas that support this species. Increased access would increase opportunities for collection of this species by hobbyists.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the giant helleborine. Groundwater withdrawals cause the cumulative reduction of spring and seep flows.	Implementation of any of the alternatives may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for the giant helleborine. This determination is based on the low likelihood that this species occurs within, or extensively within, the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and the implementation of avoidance measures if new occurrences are discovered.
Pagosa Skyrocket	No known occurrences of this species would be disturbed. From 83 to 941 acres (less than 1 to 2 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Pagosa Skyrocket were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Pagosa skyrocket.	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for Pagosa skyrocket. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

Table 3-75 Forest Service Sensitive Plant Species —All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Pagosa Springs Bladderpod	No known occurrences of this species would be disturbed. 46 to 806 acres (less than 1 to 4 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Pagosa Springs bladderpod were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Pagosa Springs bladderpod.	Implementation of any of the alternatives would have no impact on the Pagosa Springs bladderpod on federal jurisdiction. This determination is based on the low likelihood that this species occurs within the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and the implementation of avoidance measures if new occurrences are discovered.
Large Flower Triteleia (*Triteleia grandiflora*)	The types of effects to this species are the same among the alternatives and vary only according to the amount of habitat disturbed by each alternative. In general, alternatives that involve more wells and facilities have more potential to affect this species and its habitats than are alternatives with fewer wells and facilities. Potential effects to large flower triteleia include injury or death to individuals resulting from trampling or crushing by machinery, destruction of habitat, and introduction of non-native species. Disturbance to habitat may also create conditions that are conducive to establishment of non-native plant species that can out-compete native species for habitat resources, which could lead to reduction in numbers and possible local extinction of this species. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the to large flower triteleia were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the large flower triteleia	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for large flower triteleia. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

Table 3-75 Forest Service Sensitive Plant Species —All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Missouri Milk-vetch (*Astragalus missouriensis* var. *humistratus*)	The types of effects to this species are the same among the alternatives and vary only according to the amount of habitat disturbed by each alternative. In general, alternatives that involve more wells and facilities have more potential to affect this species and its habitats than are alternatives with fewer wells and facilities. Potential effects to Missouri milkvetch include injury or death to individuals resulting from trampling or crushing by machinery, destruction of habitat, and introduction of non-native species. Disturbance to habitat may also create conditions that are conducive to establishment of non-native plant species that can out-compete native species for habitat resources, which could lead to reduction in numbers and possible local extinction of this species. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Preconstruction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the to Missouri milkvetch were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Missouri milkvetch.	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for Missouri milkvetch. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

3.8.4 Cumulative Effects

The cumulative effects analysis area is defined as the Project Area and that portion of the area within the exterior bounds of the Southern Ute Indian Reservation where CBM development has and will continue to occur. The cumulative effects study area therefore encompasses 546,648 acres.

3.8.4.1 Vegetation Disturbance and CBM Development

Each of the alternatives would contribute to cumulative vegetation impacts in the Project Area. Table 3-76 through Table 3-80 display cumulative vegetation removal due to existing and proposed oil and gas development within the cumulative effects area. Other activities that would contribute to cumulative vegetation impacts in the Project Area are not quantifiable because of lack of study and associated data. These other factors are addressed qualitatively and include sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development. The vegetation types that would be most impacted are grasslands, sagebrush, pinyon juniper, and ponderosa pine. Future CBM development would remove about 9,000 acres of vegetation in addition to the 16,500 acres already impacted.

Table 3-76 Cumulative CBM Impacts to Vegetation — Alternative 1

	Project Area		SUIT Study Area			
Vegetation Type	Existing Impact (acres)	Future Impact (acres)	Existing Impact (acres)	Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	63	4,155	1,192	5,696	6.3
Sagebrush	221	67	3,897	1,118	5,303	6.2
Pinyon-Juniper	229	215	5,174	3,439	9,057	5.1
Mountain Shrub	21	10	865	248	1,144	6.0
Gambel Oak	162	140	204	404	910	3.1
Ponderosa Pine	310	390	354	710	1,764	3.4
Mixed Conifer	9	60	0	0	70	1.5
Aspen	8	15	0	0	23	1.8
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	42	0	0	156	1.7
Barren	117	10	0	0	127	5.5
Water	1	0	0	0	1	0.5
Total	1,489	1,016	14,869	7,383	24,757	5.2

Table 3-77 Cumulative CBM Impacts to Vegetation — Alternative 2

	Project Area		SUIT Study Area			
Vegetation Type	Existing Impact (acres)	Future Impact (acres)	Existing Impact (acres)	Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	128	4,155	1,192	5,761	6.3
Sagebrush	221	94	3,897	1,118	5,330	6.2
Pinyon-Juniper	229	361	5,174	3,439	9,204	5.2
Mountain Shrub	21	42	865	248	1,176	6.2
Gambel Oak	162	325	204	404	1,095	3.7
Ponderosa Pine	310	589	354	710	1,963	3.8
Mixed Conifer	9	85	0	0	94	2.1
Aspen	8	29	0	0	37	2.8
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	71	0	0	184	2.0
Barren	117	20	0	0	137	5.9
Water	1	0	0	0	1	0.5
Total	1,489	1,746	14,869	7,383	25,487	5.3

Table 3-78 Cumulative CBM Impacts to Vegetation — Alternative 5

Vegetation Type	Project Area Existing Impact (acres)	Project Area Future Impact (acres)	SUIT Study Areas Existing Impact (acres)	SUIT Study Areas Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	21	4,155	1,192	5,654	6.2
Sagebrush	221	55	3,897	1,118	5,291	6.2
Pinyon-Juniper	229	94	5,174	3,439	8,937	5.0
Mountain Shrub	21	5	865	248	1,139	6.0
Gambel Oak	162	30	204	404	799	2.7
Ponderosa Pine	310	105	354	710	1,479	2.9
Mixed Conifer	9	3	0	0	12	0.3
Aspen	8	0	0	0	8	0.6
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	39	0	0	153	1.6
Barren	117	7	0	0	124	5.3
Water	1	0	0	0	1	0.5
Total	1,489	362	14,869	7,383	24,103	5.0

Table 3-79 Cumulative CBM Impacts to Vegetation — Alternative 6

Vegetation Type	Project Area Existing Impact (acres)	Project Area Future Impact (acres)	SUIT Study Area Existing Impact (acres)	SUIT Study Area Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	49	4,155	1,192	5,682	6.2
Sagebrush	221	61	3,897	1,118	5,297	6.2
Pinyon-Juniper	229	171	5,174	3,439	9,013	5.1
Mountain Shrub	21	10	865	248	1,144	6.0
Gambel Oak	162	45	204	404	815	2.7
Ponderosa Pine	310	199	354	710	1,573	3.1
Mixed Conifer	9	16	0	0	25	0.5
Aspen	8	0	0	0	8	0.6
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	42	0	0	155	1.7
Barren	117	10	0	0	127	5.5
Water	1	0	0	0	1	0.5
Total	1,488	607	14,869	7,383	24,347	5.1

Table 3-80 Cumulative CBM Impacts to Vegetation — Alternative 7

	Project Area		SUIT Study Area			Portion of Vegetation Type (percent)
Vegetation Type	Existing Impact (acres)	Future Impact (acres)	Existing Impact (acres)	Future Impact (acres)	Total (acres)	
Grasslands	286	64	4,155	1,192	5,697	6.3
Sagebrush	221	68	3,897	1,118	5,304	6.2
Pinyon-Juniper	229	199	5,174	3,439	9,041	5.1
Mountain Shrub	21	10	865	248	1,144	6.0
Gambel Oak	162	78	204	404	848	2.9
Ponderosa Pine	310	268	354	710	1,642	3.2
Mixed Conifer	9	49	0	0	58	1.3
Aspen	8	11	0	0	19	1.4
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	42	0	0	155	1.7
Barren	117	9	0	0	126	5.4
Water	1	0	0	0	1	0.5
Total	1,488	800	14,869	7,383	24,540	5.1

3.8.4.2 Habitat Structural Stages

Each of the alternatives would contribute to cumulative effects to HSSs in the cumulative effects analysis area. Project activities that remove vegetation, as discussed above, would also remove HSSs and reset the process of ecological succession. Table 3-81 through Table 3-85 display cumulative removal of HSSs by alternative. Other activities that contribute to cumulative effects to HSSs including sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development are not quantified because of a lack of data regarding their impacts. Effects to HSSs from these activities would be in addition to the cumulative effects that have been quantified. Cumulative vegetation impacts would approach six-percent of grasslands, riparian areas, mountain shrub and sagebrush vegetation types in all alternatives due primarily to the extent of development on private lands and lands within the boundaries of the Southern Ute Indian Reservation. Cumulative impacts to other vegetation types would range from 0.3 to approximately 3 percent of each of the representative vegetation types. Approximately 3 percent or less of the forested vegetation types would be cumulatively impacted by CBM development.

Areas reclaimed after CBM development would differ substantially from undisturbed areas in terms of HSS. The short-term cumulative impact would consist of a loss of later seral stages (4A, 4B, and 4C) and an increase in early and mid-seral stages (1M, 2S, 3A, 3B, and 3C).

3.8.4.3 Wetlands, Riparian Areas and CBM Development

Much of the discussion of cumulative effects to vegetation and HSSs is also relevant to wetlands and riparian areas. Sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development have likely impacted wetlands and riparian areas via habitat loss or degradation, road develop-

ment, and degradation of water quality. These types of activities are expected to increase in number and frequency within the Project Area, commensurate with the growth in regional population. The USCAE permitting process is designed in part to minimize the cumulative effects of filling wetlands; therefore, minimal direct loss of wetlands from this and other projects is expected in the future. Cumulative degradation of wetlands and riparian areas by sediment would be minimized using BMPs and mitigation measures developed on site during the APD evaluation process.

Table 3-81 Cumulative CBM Impacts to Habitat Structural Stages — Alternative 1

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.3	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.1	5.1	0.0	5.1	5.1	0.0	0.0	5.1
Mountain Shrub	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Gambel Oak	0.0	0.0	0.0	3.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	2.5	2.9	2.4	3.3	3.5	2.5	4.7	3.4
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.2	2.1	1.6	2.2	0.0	1.5
Aspen	0.0	0.0	0.0	0.0	0.0	0.7	3.2	1.1	0.3	1.6	0.0	0.0	1.8
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Barren	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.4	6.3	6.2	5.5	3.1	5.0	5.0	1.2	4.5	4.1	2.2	4.7	5.2

Table 3-82 Cumulative CBM Impacts to Habitat Structural Stages — Alternative 2

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.4	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.2	5.2	0.0	5.2	5.2	0.0	0.0	5.2
Mountain Shrub	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Gambel Oak	0.0	0.0	0.0	3.7	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	3.2	3.3	2.5	3.8	3.8	2.6	4.8	3.8
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.1	1.5	0.4	5.3	1.8	2.3	0.0	2.1
Aspen	0.0	0.0	0.0	0.0	0.0	3.6	3.4	1.3	4.1	1.8	0.2	0.0	2.8
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Barren	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.7	6.4	6.2	5.7	4.2	5.2	5.1	1.3	4.7	4.3	2.3	4.8	5.3

Table 3-83 Cumulative CBM Impacts to Habitat Structural Stages — Alternative 5

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.0	5.0	0.0	5.0	5.1	0.0	0.0	5.0
Mountain Shrub	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Gambel Oak	0.0	0.0	0.0	2.7	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	2.5	2.8	2.4	2.8	3.0	2.4	2.8	2.9
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.3	0.3	0.0	0.0	0.3
Aspen	0.0	0.0	0.0	0.0	0.0	0.7	0.9	0.0	0.3	0.3	0.0	0.0	0.6
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Barren	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.3	6.2	6.2	5.4	3.0	5.0	4.9	0.9	4.2	3.8	0.5	2.8	5.0

Table 3-84 Cumulative CBM Impacts to Habitat Structural Stages — Alternative 6

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.1	5.1	0.0	5.1	5.1	0.0	0.0	5.1
Mountain Shrub	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Gambel Oak	0.0	0.0	0.0	2.7	2.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.0	0.5
Aspen	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.6	0.6	0.6	0.6	0.0	0.6
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Barren	5.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.4	6.2	6.2	5.4	2.7	5.0	5.0	1.5	4.4	3.9	1.1	3.1	5.1

Table 3-85 Cumulative CBM Impacts to Habitat Structural Stages — Alternative 7

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.3	6.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.1	5.1	0.0	5.1	5.1	0.0	0.0	5.1
Mountain Shrub	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Gambel Oak	0.0	0.0	0.0	2.9	2.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	1.3	1.3	1.3	1.3	1.3	1.3	0.0	1.3
Aspen	0.0	0.0	0.0	0.0	0.0	1.4	1.4	1.4	1.4	1.4	1.4	0.0	1.4
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Barren	5.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.4
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.4	6.3	6.3	5.5	2.9	5.0	5.0	2.0	4.4	4.0	1.7	3.2	5.1

3.8.4.4 Vegetation Restoration and CBM Development

Interim and permanent vegetation restoration would occur in areas of existing and proposed CBM development. These activities are conducted to ensure that CBM-related disturbances are temporary and do not cause permanent loss of vegetation and productivity in the Project Area. Still, many other disturbances that occur in the Project Area are not subject to similar restoration requirements and have greater potential to cause permanent loss of vegetation, introduction of noxious weeds, and loss of vegetative productivity.

3.8.4.5 Noxious Weeds and CBM Development

The cumulative effect of noxious weed infestations in the Project Area has not been quantified; however, agriculture and residential development have all played a substantial role in the introduction and spread of noxious weeds. Agricultural and residential uses are widespread in the cumulative effects analysis area and are not subject to the same strict weed control measures as is oil and gas development. CBM development would be subject to mitigation measures for weed control, minimizing any cumulative impacts of noxious weeds on vegetation in the Project Area. Ongoing agricultural and residential land uses would continue to be the primary causes for introduction and spread of noxious weeds throughout the Project and cumulative effects area.

3.8.4.6 Old Growth Ponderosa Pine and CBM Development

The cumulative loss of old growth stands to CBM development on NFS lands in the Project Area is only slightly higher than the Project effects shown on Table 3-73. Ten acres of field-verified old growth were lost to the construction of Forest Service Road 615, one well pad, and a short segment of unnumbered road accessing this well pad in the past. Although only a small loss of old growth can be quantified, a much larger amount has been lost over the past century to timber harvest and wildland fire. Of the 34,690 acres of ponderosa pine stands in the

Project Area, a larger proportion probably was old growth before Euro-American settlement and development of the Project Area.

Similar patterns in loss of old growth ponderosa pine forests are seen across the entire SJNF. Of the 260,940 acres of ponderosa pine stands on the SJNF, 15,020 acres (5.8 percent) are currently old growth (FS 2003e). A large proportion of the old growth ponderosa pine has been harvested, mostly with partial cuts that removed the largest trees from the affected stands, or lost due to wildland fire. Since 1990, 314 acres of old growth ponderosa pine have been harvested on the SJNF, and 332 acres were burned during the Missionary Ridge Fire in 2002 (FS and BLM 2003).

There has been a general reduction in the extent of old growth ponderosa pine stands. More recently, most remaining old growth stands have been protected. The extent of old growth ponderosa pine should increase in the future. Old growth ponderosa pine stands totaling 1,080 acres are within the analysis areas of future timber sales on the SJNF (FS and BLM 2003), although it is expected that few, if any, of these stands will actually be harvested. Approximately 365 acres of old growth pine fall within the boundaries of existing oil and gas leases on the western side of the SJNF outside of the Project Area. No data are available for the eastern side of the SJNF (FS and BLM 2003). Oil and gas development may or may not occur within these stands in the future.

3.8.4.7 Ecological Processes and CBM Development

The incremental effects of CBM development on ecological processes, such as fire and insect and disease infestations, are primarily cumulative because of the long period and widespread, landscape scale of these processes. Natural fire regimes have been and will continue to be altered. CBM development would likely result in increased firefighting efforts across the Project Area to protect facilities and further alter natural fire regimes. Future fire regimes are more likely to be dictated by the extent of residential development on private lands, the continuing accumulation of unnaturally high fuel loads in many vegetation types, and long-term weather trends, such as drought. Likewise, insect and disease infestations across the landscape would be more affected by activities beyond the scope of the current project than by project activities. Current and future droughts will be the primary cause of *Ips* beetle outbreaks. Mitigation measures would be used to reduce the potential for the proposed project to affect beetle outbreaks.

3.8.4.8 Federally Listed Threatened, Endangered, and Proposed Plant Species, FS Sensitive Plant Species, and BLM Sensitive Plant Species

The cumulative effects to federally listed threatened, endangered, and proposed plant species are presented in Table 3-74. The cumulative effects to FS and BLM sensitive plant species are presented in Table 3-75.

3.8.5 Mitigation and Monitoring

The following are comprehensive mitigation measures that would be utilized to minimize adverse environmental effects to vegetation. These measures include

avoidance strategies to protect old growth and rare plant species and other vegetation types as needed, the use of best management practices, noxious weed control strategies, use of native seed mixes and weed free hay in reclamation, and strict reclamation requirements. Best management practices (the watershed conservation practices handbook) are effective measures that have been utilized Forest Service wide. Likewise, the other requirements listed below are standard mitigation practices that are used on a wide range of projects that have repeatedly demonstrated effectiveness. The effectiveness of mitigation approaches would be monitored by mineral program managers and adjustments or repeat treatments would be prescribed as field conditions warrant. Unless otherwise stated, the following measures would be funded by the companies.

- Minimize disturbance to vegetation by clearing and otherwise disturbing vegetation within the smallest area needed for safe and efficient development, production, and maintenance.
- Avoid old growth ponderosa pine stands wherever possible, and minimize impacts to individual large, old trees when avoidance is not possible.
- Protect snags and down-dead logs to the extent possible. Snags and logs outside of disturbance areas should be removed only when they pose a hazard to the human life and property.
- Locate well pads, compressors, and other non-linear facilities outside of riparian areas, wetlands, and floodplains to the extent practical to protect these features.
- Avoid crossings of wetlands and riparian areas by linear features such as pipeline, roads, and power lines to the extent practicable. Where crossings cannot be avoided, impacts should be minimized through use of the following measures:
    - All crossings of wetlands and other waters of the U.S. should comply with USACE regulations (for example, Nationwide Permits 12 and 14). If potential effects exceed the limits of the nationwide permits, individual permits should be obtained.
    - All use of nationwide and other USACE permits should be documented. Where notification of the USACE is not required by permit conditions, the companies should submit documentation of compliance with nationwide permits to the USACE annually.
    - Develop site-specific mitigation plans during the APD, Plan of Development (POD), or Sundry Notice approval process for all proposed disturbance to wetlands and riparian areas.
    - Apply all applicable standards from FS Handbook 2509.25, the Watershed Conservation Practices Handbook (FS 2001c), on NFS lands. In particular, 12.1 Standard (3) should be applied: "In the water influence zone next to perennial and intermittent streams, lakes, and wetlands, allow only those actions that maintain or improve long-term stream health and riparian ecosystem condition."
    - Construct crossings perpendicular to wetlands and riparian areas.
    - Disturb wetland and riparian areas only during dry conditions (that is, during late summer or fall), or when the ground is frozen during the winter.

- Do not deposit waste material below high-water lines in riparian areas, floodplains, or natural drainageways.
- Locate the lower edge of soil or other material stockpiles outside the active floodplain.
- Locate drilling mud pits outside of riparian areas, wetlands, and floodplains.
- Reshape disturbed channels to their original configuration and ensure they are properly stabilized.
- Begin reclamation of disturbed wetlands and riparian areas immediately after project activities are complete.
- If production is established, interim reclamation of unused portions of the well pad should begin as soon as feasible. If the well is not productive, the entire well site should be reclaimed.
- Reclaim the reserve pit and that portion of the location and access road not needed for access and production facilities. Drill cuttings should be placed in a trench and buried when operations end. Stockpiled topsoil should be spread evenly over the disturbed area. Enough topsoil should be retained to reclaim the remainder of the location at abandonment. This remaining stockpile of topsoil should be seeded in place using the prescribed seed mixture.
- Broadcast seed between September 1 and December 1 or at other times with prior approval of the Authorized Officer.
- Use certified weed-free seed. The preference is for local, native seed. Where local, native seed is not available, non-local native and non-native seed may be used, subject to prior approval of the Authorized Officer. Certification tags that are removed from seed mixtures should be provided to the Authorized Officer.
- Specify seed mixes during the APD and POD approval process. In addition to seeding, shrubs and trees that were present before construction should be replaced during reclamation. Shrubs may be seeded; live trees should be planted in previously forested areas.
- It is recommended that the seed mixture be applied with a drill. If the seed is broadcast, some means such as a harrow should be used to incorporate the seed into the soil.
- Certified weed-free mulch may be required on locations with an inadequate supply of removed vegetation for use as mulch.
- The entire well pad should be fenced and a gate or cattle guard provided where the well access road crosses the fence. The fence should be built within 7 days after initial well drilling is completed. The fence should be maintained until the areas that are not needed for production are revegetated.
- Begin final reclamation on all disturbed areas as soon as feasible after the site it abandoned. The same methods used for interim reclamation apply to final reclamation. Gravel surfacing, if used, should be removed from the well pad and disposed of at an approved site. The well site should be contoured to pre-construction conditions. Stored topsoil should be spread over the entire disturbed area. All areas of soil dis-

turbed by operations should be scarified to at least a 4-inch depth and drainage structures should be installed at specified locations.

- Continue reclamation efforts until all areas are successfully revegetated and accepted. Reclamation should be considered successful when the desired vegetative species are established, erosion is controlled, weeds are considered a minimal threat, and it is likely that ground cover will return to a desirable condition.

➢ Companies submit a noxious weed control plan as a component of the APD and POD approval process. Components of this plan should include:

- The operator is responsible for the treating and eliminating any noxious weeds that may be introduced and established on disturbed areas. This responsibility remains until the disturbed areas are successfully reclaimed and accepted.
- Complete an inventory of noxious weeds at each site before disturbance. Treat any infestations of noxious weeds before disturbance begins to reduce the risk of spread during construction.
- Pressure-wash heavy equipment before it enters public lands and when it moves between areas on public lands.
- Monitor all disturbed areas for noxious weeds for a minimum of 3 years after interim and final reclamation.
- Treat all noxious weed infestations for a minimum of 5 years after they are detected.
- Treat all noxious weeds by methods to be approved by the Authorized Officer. These methods may include biological, mechanical, or chemical treatments. Should chemical or biological treatment be requested, the operator must submit a Pesticide Use Proposal to the Authorized Officer 60 days before the planned application date.
- Minimize the creation of fuel concentrations by chipping, piling, and burning, or removing from the site any woody debris from construction.

➢ To the extent practical, the operator should take measures to prevent uncontrolled fires on the area of operation and to suppress uncontrolled fires resulting from operations. All fires should be reported to the FS/BLM immediately after they are detected.

➢ When trees (including pinyon pine, juniper, ponderosa pine, and Douglas-fir) are cleared for construction of oil and gas facilities during periods of insect activity (April through October), all cut material should be disposed of within 3 weeks to prevent this material from attracting or harboring insects. At other times of the year, removal of cut material would not be required within 3 weeks; however it should be removed at least 3 weeks before April 1, the expected date that insects emerge in spring. Acceptable disposal methods include burying material on site, chipping and removing chips from the Project Area, or removing material from the Project Area without chipping. Smaller materials would be removed under certain conditions. Materials less than 4 inches in diameter do not have to be removed if scattered in a thin layer so that they dry thoroughly

within a 3-week period. If materials are stacked or piled such that they do not dry quickly, only materials less than 2 inches in diameter may remain on site.

- If deemed necessary by the agencies, trees should be protected from infestation by bark beetles through preventative spraying of selected trees. Preventive spraying is a proven method of repelling bark beetle infestation and can reduce future hazards to public safety posed by unstable, dying trees. Spray pesticides can include Carbaryl (commonly known as Sevin) or Permethrin (commonly known as Astro) on the trunks and branches of selected trees. These treatments would: (1) follow manufacturer's safety recommendations for certified applicators; (2) take place only during dry weather conditions to avoid water contamination; and (3) take place only when wind speeds are low to reduce drift. Sites should be closed to the public during spraying and until the pesticide dries completely, probably only for a few days. Signs should be posted to alert the public as to the trees that have been sprayed.
- Conduct pre-construction surveys for Knowlton's cactus, Aztec milkvetch, giant helleborine, Pagosa skyrocket, and Pagosa Springs bladderpod in all potential disturbance areas that are identified as suitable habitat during the pre-construction phase of the project. At a minimum, the entire occupied area should be avoided by all ground-disturbing activities

3.8.6 Conformance to Existing Plans and Policies

3.8.6.1 BLM Lands

The San Juan/San Miguel Planning Area RMP (BLM 1985), and the Decision Record for the Standards for Public Land Health (Standards) and Guidelines for Livestock Grazing Management (BLM 1997) contain the following resource objectives and standards. These resource objectives and standards apply only to BLM lands. The resource objectives and standards discussed below may be affected by the proposed project. Other resource objectives and standards that are related to vegetation are not included here because they would not be affected by the proposed project.

3.8.6.1.1 Resource Objectives

No activities will be permitted in habitat for threatened, endangered, or sensitive species that would jeopardize their continued existence (RMP, page 12).

3.8.6.1.2 Standards

Standard 2: Riparian systems associated with both running and standing water function properly and have the ability to recover from major disturbance such as fire, severe grazing, or 100-year floods. Riparian vegetation captures sediment and provides forage, habitat, and biodiversity. Water quality is improved or maintained. Stable soils store and release water slowly (Standards, page 6).

Standard 3: Healthy, productive plant and animal communities of native and other desirable species are maintained at viable population levels commensurate with the species and habitat's potential. Plants and animals at both the community and population level are productive, resilient, diverse, vigorous, and able to

reproduce and sustain natural fluctuations and ecological processes (Standards, page 7).

Standard 4: Special status, threatened, and endangered species (federal and state), other plants and animals officially designated by the BLM, and their habitats are maintained or enhanced by sustaining healthy, native plant and animal communities (Standards, page 7).

3.8.6.1.3 Conformance with Resource Objectives and Standards

As documented in the Biological Assessment (Appendix H) and Biological Evaluation (Appendix I), the proposed project would not jeopardize the continued existence of any threatened, endangered, or sensitive plant species under any of the five alternatives. Although there may be minimal effects to some species, viable populations of special status and other plant species and their habitats are likely to be maintained in the Project Area. Mitigation measures would help to ensure that adverse effects to special status and other species are minimized.

The preceding sections discuss the potential effects of the project alternatives on vegetation. Although negative impacts are predicted for each alternative, the extent of these effects is low in relation to the amount of each plant community that exists in the Project Area. Productive, resilient, diverse, vigorous, and sustainable plant communities would be maintained throughout implementation of the project. These communities would be replaced to the extent practicable after the project is complete.

Mitigation measures that promote avoidance of riparian and wetland areas have been incorporated into each of the alternatives. Implementation of these measures would ensure that riparian systems continue to function properly.

3.8.6.2 NFS Lands

The LRMP for the SJNF (FS 1992) contains the following direction and guidelines. The guidelines discussed below may be affected by the proposed project. Other guidelines that address vegetation management are not included here because they would not be affected by the proposed project.

3.8.6.2.1 Management Activity: Diversity on National Forests and National Grasslands

Forest Direction

General Direction

Maintain structural diversity of vegetation on units of land 5,000 to 20,000 acres in size, or 4th-order watersheds that are dominated by forested ecosystems (LRMP page III–11).

In forested diversity units, maintain at a minimum on each treated area, an average of 20 to 30 snags (in all stages of development) per 10 acres, well distributed over the diversity unit (LRMP page III–11).

Guidelines

In forested areas of a unit, 5 percent or more should be in old growth and 5 percent or more should be in grass/forb stages (LRMP page III–11).

Provide at a minimum an average of six to 10 snags per 10 acres of the following minimum diameters (where biologically feasible): ponderosa pine, Douglas-fir, and spruce-fir: 10 inches d.b.h.; aspen and lodgepole pine: 8 inches d.b.h. (LRMP page III–11).

Retain an average length per acre of down-dead logs (where biologically feasible) of the following minimum diameters: ponderosa pine, Douglas-fir, and spruce-fir: 12 inches diameter and 50 linear feet/acre; aspen and lodgepole pine: 10 inches diameter and 33 linear feet/acre (LRMP page III–12).

3.8.6.2.2 Conformance with Guidelines

Current data show that 6.5 percent of the NFS lands in the Project Area are in the grass/forb seral stage. Of the forested areas on NFS lands in the Project Area (the diversity unit for this analysis), between 2.3 and 3.1 percent is old growth. The lower percentage assumes that a large portion of the Gambel oak type is potential ponderosa pine, and aspen is also included in the percentage calculation. Of the ponderosa pine that now exists within the national forest portion of the Project Area, 3.8 percent is old growth. The structural diversity of the project area is such that the guideline is currently being met for the grass/forb seral stage, but not being met for old growth.

The amount of grasslands would be reduced slightly, to between 6.2 and 6.4 percent of NFS lands in the Project Area, depending on the selected alternative. The minimum 5 percent grass/forb guideline would continue to be met.

The alternatives would impact 36 acres of old growth pine or less. Consequently, old growth would be reduced to between 2.2 and 3.1 percent of forested areas on NFS lands in the Project Area or between 3.6 and 3.8 percent of ponderosa pine stands on NFS lands in the Project Area, depending on the alternative selected. These reductions in the old growth stage would move the Project Area further away from the Standard and Guideline that the Project Area is currently not meeting. The changes in the percent of old growth described above are important considering the rarity of old growth stands for the ponderosa pine forest type in the Project Area, across the SJNF, and throughout the Southwestern U.S (Romme et al. 2003, SJNF Old Growth Inventory), and considering the timeframes (centuries in many cases) for other forested lands in the Project Area, which currently are in younger seral stages, to succeed into the old growth stage.

It should also be noted that the actual number of acres of old growth affected by the alternatives only includes a 40-foot-wide swath of land running through the old growth stand (in the case of road construction) and a 1 acre well pad, not the total acres of the whole old growth stand. Dissecting or fragmenting an old growth stand by road or well pad construction would adversely affect the ecological integrity of the whole old growth stand by removing ecological components that change the composition and structure of the stand (Angermeier and Karr 1994). Removing any of the large and old ponderosa pine trees that are rare components within this project area would eliminate the genetic diversity that these individuals contain and would greatly slow the successional process of Gambel oak-dominated shrublands succeeding back to ponderosa pine forests, since these seed-producing trees would be removed in a landscape where ponderosa pine seed-producing trees are not abundant and not well distributed.

The lack of compliance with the Forest Plan Standard and Guideline associated with the old growth stage implies that the structural diversity of vegetation (as described in the General Direction for Diversity on National Forests) in the Project Area (diversity unit) is not adequate. Additional loss of old growth stands through the implementation of alternatives as described above would mean that achieving the desired vegetation structural diversity for the Project Area and conforming to the Standard and Guideline of 5 percent would take even longer to achieve than it would if no actions are implemented. This could have adverse effects on wildlife species that utilize and rely on old growth habitats to some extent (see wildlife section of this document).

Through field observation, it is believed that the guidelines for snags and down-dead logs are not being met in ponderosa pine stands within the Project Area. Firewood cutters have long accessed the area. Data on snags and down-dead logs from old growth stands indicate that these areas are stands where Standards and Guidelines are being met, as would be expected in old growth stands. Because these are the oldest stands and have never been commercially harvested, they tend to have more snags and down-dead wood than are found in other areas. Snags and down-dead logs would be removed on well pads, along roads, and at other facility sites if necessary to meet safety and design requirements for construction and operations of these facilities. Mitigation measures are recommended to protect these important habitat features to the greatest extent possible during project implementation.

3.8.7 Unavoidable Adverse Effects

Unavoidable adverse effects are adverse effects that would occur because of the proposed project, despite implementation of mitigation measures designed to minimize adverse effects. Vegetation, including habitat structural stages, would be impacted or removed. Small amounts of wetlands and riparian areas would be impacted or removed. Portions of old growth stands of ponderosa pine would be removed. Infestations of noxious weeds would increase and displace native vegetation. Fire regimes would be altered. Potential habitats for special status plant species would be lost.

3.8.8 Irreversible and Irretrievable Commitments of Resources

3.8.8.1 Irreversible Commitments

Loss of old growth stands of ponderosa pine beyond the life of the project would be an irreversible commitment because restoring functional old growth stands would be an extremely long-term process.

3.8.8.2 Irretrievable Commitments

Irretrievable commitments would include: loss of vegetative cover until reclamation is successful, loss of late-serial habitat structural stages beyond the life of the project, loss of some riparian and wetland vegetation over the life of the project, loss of potential habitats for special status plant species, and decreased productivity of native plant communities because of increased infestations of noxious weeds.

3.9 Wildlife

This section summarizes several resource reports that collectively address the potential effects of the alternatives on wildlife and fisheries resources in the Project Area. The complete analyses are presented in the following resource reports: the Biological Assessment (Appendix H), Biological Evaluation (Appendix I), MIS Analysis (Appendix J), Migratory Bird analysis (Appendix K), and State of Colorado Threatened and Endangered Species analysis (Appendix L).

3.9.1 Issues

Issue 6: The effects of additional CBM development on wildlife and fisheries and their habitats.

- Will increased CBM development result in increased wildlife harassment, road-kill, hunting pressure, and wildlife displacement?
- What are the impacts of additional CBM development on important game species?
- How will CBM development affect the suitability of wildlife habitat? Will development cause a loss of high-value and critical big game winter ranges, habitat loss, habitat fragmentation, and disruption of migration routes?
- Will CBM development affect the long-term viability of wildlife populations?
- How will downstream fisheries be affected as a result of dewatering of the Fruitland coal? Will groundwater and surface water quality and quantity change, and how will that affect fisheries?

Issue 16: The effects of additional CBM development on Federal and State listed threatened, endangered, proposed, candidate, and sensitive animal species and their habitats.

3.9.2 Regional Characterization

The Project Area is located at the interface of the Colorado Plateau physiographic province and the Southern Rocky Mountains physiographic province (Mutel and Emerick 1992). The location of the Project Area at this interface makes it valuable to many species of wildlife. Wildlife species and habitat elements common to both of these physiographic provinces are found in the Project Area. Species that utilize the higher, moister, conifer-dominated habitats of the Rocky Mountains are found in the eastern third of the Project Area. Species more typical of the warmer, drier Colorado Plateau occur in the western two-thirds of the Project Area. Migratory species, such as big game and many bird species, move back and forth across the Project Area with the seasons.

3.9.3 General Wildlife Mitigation Measures

In addition to LRMP standards and guidelines, the following mitigation measures are recommended to reduce or minimize effects of CBM development and pro-

duction on wildlife and their habitats. These measures are common to all alternatives. Mitigation measures specific to individual wildlife species are listed in later sub-sections. Unless otherwise stated, the following measures would be funded by the companies.

- Minimize the number and length of new access roads. This measure reduces direct habitat loss and loss of habitat effectiveness.
- Where possible, construct access roads to new wells as spurs from the existing road system rather than as separate primary access roads. This measure reduces direct habitat loss and loss of habitat effectiveness.
- Prohibit employees and contractors from bringing dogs or carrying firearms on the site. This mitigation reinforces standard working agreements with industry and is applied to reduce wildlife harassment.
- Continue to implement periodic employee and contractor wildlife-awareness programs, covering seasonal wildlife requirements and sensitivities, how disturbances affect wildlife, and ways personnel can reduce disturbances. Experience has shown that these forums promote effective industry participation in implementing and enforcing mitigation measures.
- Install mufflers or screens on exhaust systems to avoid wildlife entrapment and mortality.
- Avoid construction within riparian and wooded riparian areas. This measure reduces critical habitat loss and potential for stream sedimentation.
- Protect and retain snags and down-dead logs to the extent possible. All snags and logs may be removed from areas of active construction and ground disturbance but snags and logs outside of disturbance areas should be removed only when they pose a hazard to human life and property. This will minimize loss of habitat to snag and log dependent species.
- Minimize disturbance by clearing and otherwise disturbing only vegetation within the minimum area needed for safe and efficient development, production, and maintenance. This will minimize conversion of habitat.
- Inventory for and prohibit construction or other intrusive activities within ¼ mile of any active raptor nest during the nesting season between March 1 and August 15. Inventories shall occur no more than 1 year prior to construction or other intrusive activities and preferably within the same calendar year as the project activity. Activities within ¼ mile of active or inactive nests between March 1 and August 15 will be evaluated on a case-by-case basis upon written request to the Authorized Officer. Restrict new well locations and ROWs to at least ¼ mile from a raptor nest or winter roost. This mitigation is intended for raptors utilizing stick built nests or communal winter roosts. Cavity nesting species impacts are mitigated through provisions for snag components. This measure is demonstrated to reduce human/wildlife conflicts that can lead to nest abandonment and/or area avoidance. Some additional species-specific measures are required and are identified in the following sections. This mitigation is intended for raptors utilizing stick built nests.

- Minimize the number of well-monitoring trips by coordinating well visits to limit traffic or installing automated monitoring systems. This measure reduces human/wildlife conflicts and loss of habitat effectiveness.
- No activities other than routine well activities (activities that are conducted in the course of maintaining production operations at a well site such as daily site visits, minor repairs on surface equipment or removal of produced water by truck) shall take place from December 1 to April 30. Other activities, such as construction and heavy maintenance of facilities, during this period will be evaluated on a case-by-case basis upon written request to the FS or BLM for consideration. This measure reduces human/wildlife conflicts and loss of habitat effectiveness during the critical winter season.
- Take measures to exclude and protect wildlife from drilling and production fluids. These measures include but are not limited to: fence and place solid or mesh covers over reserve pits to exclude and protect wildlife species form drilling fluids. Properly designed covers have been shown to be effective and are commonly used throughout the industry for these purposes.
- Gate all newly created access roads and require all industry personnel and their sub-contractors passing through locked gates to close and relock each gate immediately upon passage. Measures shall be taken to effectively close such roads to all motorized use including full-size vehicles, ATVs, motorcycles and other OHVs, and snowmobiles. Road closures reduce the risk of mortality, displacement, and impacts to wildlife habitat effectiveness.
- For all roads with restricted public access for all or some portion of the year, require industry to post a sign on the closure gate during the closure period reminding industry personnel that the gate must be kept closed and locked at all times during the closure period. Such signs are regularly used by industry in the Project Area and the presence of these signs has been demonstrated to increase gate closure consistency. Gate closures are an effective means of maintaining wildlife habitat capability in key wildlife areas and during critical time periods.
- Where livestock walk-around wire passages are needed at gate closure points for use by livestock permittees, provide an effective means of locking the wire passage to prevent motorized use during closure periods. This measure reduces human/wildlife conflicts and loss of habitat effectiveness during the critical winter season.
- Permanently close all roads that are not designated as open in the travel management plan, roads not used by industry to access CBM sites and not used for administrative purposes. Measures will be taken to effectively close such roads to all motorized use including full-size vehicles, ATVs, motorcycles and other OHVs, and snowmobiles. Measures include but are not limited to: block roads at least one site distance up the roadbed by placement of large boulders, livestock gates, or earthen barriers interspersed with tree trunks and branches, or obliterated and recontoured back to the original slope. This mitigation would offset the impact of new roads. In most cases, this mitigation has been effective in

deterring public motorized traffic, thereby reducing wildlife displacement, mortality, and loss of habitat effectiveness.

- Upon road decommissioning, obliterate roads, re-contour back to original slope, and re-vegetate with an appropriate seed mix (this could include seedlings and/or saplings). This measure, in concert with road closures and off-road travel restrictions, would somewhat restore pre-project conditions and improve habitat effectiveness for wildlife.
- Restrict public access (including full-size vehicles, ATVs, motorcycles and other OHVs, and snowmobiles) from well access roads not designated as open to the public and limit road use to authorized CBM operations only. Also prohibit CBM employee use of recreational off-road vehicles unless such equipment is necessary for job performance (Bromley 1985). This mitigation reinforces standard working agreements with industry. It is believed that this mitigation would be effective for maintaining habitat capability and reducing wildlife mortality and dispersal.
- For all roads with restricted public access for all or some portion of the year, post signs informing the public about their allowable use status. These should be status and/or informational signs posted at restriction points (i.e. closure gates) that clearly describe restriction timing, current restriction status and allowable modes of transportation and pubic use. This measure increases compliance with access restrictions and reduces human/wildlife conflicts and loss of habitat effectiveness during the critical winter season.
- Require that all trash be transported off-site daily or stored in bear-proof containers (McClellan and Shackleton 1988). This requirement shall apply to all compressor sites, well pads, and other infrastructure sites during the construction phase. No overnight storage of wildlife attractant materials shall be permitted at any infrastructure site during the production phase. This mitigation would effectively reduce habituation by wildlife to human food sources.
- To the extent practicable, use noise reduction technologies at all infrastructure sites during construction and production phases. It is believed that this mitigation would be effective at reducing some of the wildlife displacement that may occur from areas immediately adjacent to infrastructure facilities (Harding and Nagy 1980).
- Schedule routine maintenance activities to occur between 9:00 a.m. and 3:00 p.m. at facilities in big game winter ranges during critical seasons and at facilities that must be accessed by roads through sensitive habitat.
- Remove all chemicals from project sites to avoid exposure to wildlife. This would allow wildlife to forage in developed areas without risk of exposure to harmful chemicals.
- Re-seed unused portions of roads and well pads as quickly as possible after disturbance with native grass, shrub, and forb seed mixtures to encourage faster re-growth of native nesting and foraging habitat in disturbed areas. Re-seeding immediately after disturbance has been shown to significantly reduce the time for reestablishment of vegetation on disturbed sites, thereby restoring wildlife forage and hiding cover more quickly than solely natural re-seeding.

- Restrict the use of open reserve pits during drilling or production unless absolutely necessary. Where possible, capture all liquid in containers and dispose of in an approved manner. Where reserve pits are necessary, cover all pits with mesh or other covers that prevent bird and mammal entry. If reserve pits are necessary, properly designed covers have been shown to be effective for excluding wildlife and are commonly used by industry for this purpose. Conduct spot checks to assure that proper designs are used.
- All mitigation measures described in Section 3.1.4 (*Mitigation and Monitoring*), Section 3.6 (*Surface Water Resources*), and Section 3.7 (*Soils*) intended to reduce sediment inputs to surface waters also apply to aquatic habitat and fisheries. No additional measures are recommended for brown trout.
- Continue ongoing and encourage future participation in research efforts designed to evaluate wildlife mitigation and habitat enhancement effectiveness. Existing wildlife mitigation and habitat enhancement methods could be modified and/or replaced as a result of this research. Participants in these research efforts could include state, local, and federal agencies and operators in the Project Area.
- Add additional, site-specific mitigation measures to protect wildlife and their habitats to individual APDs as Conditions of Approval, as conditions warrant.

3.9.4 General Wildlife Environmental Consequences

Wildlife habitats directly affected by development of new well pads, roads, pipelines, and compressors represent a small proportion of all habitats present. However, construction and operation disturbances emanating from these areas reduce habitat effectiveness for wildlife in a larger surrounding area. These disturbance areas vary in width depending on a number of factors including intervening terrain and vegetation, the type and duration of disturbance, the species of wildlife present, and the time of year. Elk and deer are the wildlife species that would be most affected by development under all alternatives. Adverse affects are primarily associated with disturbance on, and displacement from, winter ranges.

Impacts to wildlife would be greatest onsite and primarily related to human disturbance and habitat loss. Construction impacts resulting in initial habitat loss would extend over approximately five years for all alternatives. Operational impacts and disturbances resulting from potentially increased public access would be the most significant wildlife related impact associated with the project. These impacts would be far greater from a wildlife perspective than the relatively small acreages of habitats directly lost to roads and well pads. Operational impacts resulting in disturbances to wildlife on important seasonal ranges would be long term unless mitigation such as road closures and remote well monitoring telemetry are utilized. Remote telemetry could effectively limit traffic to one well visit per week, maintaining habitat integrity. Offsite impacts, related to disturbance of wildlife on seasonal ranges, such as highway mortality, habitat loss, and game

damage to private property, should be minor relative to on-site impacts. General summaries for each of these impact types are presented below.

3.9.4.1 Direct Habitat Loss

Road, well pad, and other facility construction would result in direct loss of wildlife habitat under each alternative. Habitat loss would reduce available forage and habitat components in the affected area. Habitats next to those directly disturbed may be degraded by changes in vegetation, including the invasion of noxious weeds.

The direct loss of habitat is a function of the number of wells, roads, and other facilities constructed under each of the alternatives. Alternative 2 would result in the largest habitat loss, 1,825 acres, followed in descending order by Alternatives 1, 7, 6, and 5 (388 acres). Certain habitat types would be affected more than others would but, overall, there would not be a direct loss of habitat in excess of 2 percent for any species across the Project Area because of new CBM development.

Most of the habitat impact would be on national forest in the HD Mountains, because it is currently the least developed and would experience the most new development. The west side of the Project Area is extensively developed as agricultural and residential land and has experienced the most CBM development to date. Future CBM development on the west side of the Project Area would add a small increment of direct habitat loss to the landscape. To partially offset this impact, unused portions of well sites would be restored during the production phase. At the end of the production phase, all facilities would be removed and disturbed areas restored.

The period that impacted land would be unsuitable as wildlife habitat is variable and would depend on well lifespan, restoration techniques and success, and local weather. But generally, restoration of habitats dominated by grasses and forbs should be successful within several years. Where the goal is to restore habitats dominated by shrubs and trees, re-growth of young stands to those mature structural stages may take decades or more. Consequently, the disturbance of forest and shrub habitats would represent a long-term impact beyond the end of the production phase to those species that depend on such vegetation for forage or shelter. A small portion of the roads constructed for gas field development would not be reclaimed, but would be maintained as part of the permanent road system, resulting in permanent loss of wildlife habitats. Conversely, some existing roads in the National Forest portion of the Project Area have been removed from the permanent road system and would revert to suitable habitat conditions over time.

3.9.4.2 Habitat Effectiveness

The scientific literature supports quantitative analysis of habitat effectiveness impacts for elk and mule deer. For other wildlife species, surrounding habitat that which is directly disturbed would be reduced in habitat effectiveness, but the extent of that area is not well known or defined by scientific study.

Wildlife may avoid increased human activity, equipment operation, vehicular traffic, and noise associated with all phases of each alternative and prefer other

locations. This avoidance would result in the under-utilization of otherwise suitable habitats; therefore, the effectiveness of these habitats in supporting wildlife would be diminished. Similarly, the displacement of wildlife from disturbed areas may lead to the overuse of suitable habitats in undisturbed areas, increasing competition for limited resources. Wildlife distribution patterns would be altered. The degree of habitat avoidance would vary between species and among individuals of any particular species. Development would not occur in a manner that affects only certain, isolated parts of the Project Area at a particular time. For this reason, no attempt has been made to predict temporal patterns of loss of habitat by affected wildlife. Alternative 2 would cause the greatest loss of habitat effectiveness, and thus capacity to support wildlife, followed in descending order by Alternatives 1, 7, 6, and 5.

Within the broad category of habitat effectiveness, several factors can be measured and discussed individually. These include road density, hunting pressure/harassment, and displacement. Each of these factors is analyzed below.

3.9.4.2.1 Road Density

Road-density increases would be the greatest for alternatives with more proposed wells. The greatest relative increases in road density would occur primarily on NFS land for Alternatives 1, 2, 6, and 7, because development would be focused on land that has low current density and limited access. Alternative 5 would result in minor road development on NFS land; thus, the small increase in road density would be distributed across private and state ownerships relatively evenly.

Road density is related to habitat effectiveness and is a good measure for estimating indirect effects on big game (Rowland et al. 2000). Project-induced increases in road density on NFS land, and potential for human-wildlife conflict, would be greatest in Alternative 2, followed in descending order by Alternatives 1, 7, 6, and 5. Project design and conservation measures to restrict traffic on roads, close roads, and restrict OHV use, as discussed in Section 3.9.3 General Wildlife Mitigation Measures, are designed to minimize negative effects to habitat effectiveness.

3.9.4.2.2 Hunting Pressure/Harassment

Between 43 and 202 miles of new road and pipeline would be constructed under the alternatives. The roads would provide increased access to public land in the Project Area as a whole; potentially leading to both increased legal-hunting pressure and poaching. Private landowners would continue to control hunting on split-estate and private lands. Alternatives where more new roads would be constructed on public land, such as Alternatives 1, 2, and 7 would result in a potentially greater increase in hunting pressure and harassment of game species than alternatives with fewer new roads on public land, such as Alternatives 5 and 6. Public road closures would partially mitigate this impact, but the expanded road system would be open to foot and horseback traffic, making travel throughout large portions of the Project Area easier than currently experienced. The existing road and trail system is open to ATVs.

3.9.4.2.3 Displacement

Displacement during the construction phase may alter patterns of habitat use and movements for individual animals, but would result in low, overall disruption of seasonal habitat use or movement for entire herds because of the large areas occupied by these herds and the scattered nature of anticipated development. Displacement during the production phase would result in only minimal alteration of habitat use and movement patterns for both individual animals and entire herds, because of habituation to regular low-grade disturbance (Yarmoloy et al. 1988). Nevertheless, the additive effect of displacement events on big game could be detrimental to individual animal health or condition, particularly in areas of concentrated development.

3.9.4.3 Vehicle Collisions

Increased vehicle traffic is expected during all phases of the project under each alternative. The potential for vehicle collisions with wildlife species is directly correlated to the volume of traffic. Project-related traffic volume would be greatest during the construction phase and diminish during the production and abandonment phases.

Most project roads would be designed for slower speeds and not likely to cause a substantial increase in vehicle collisions. Most collisions occur on county roads and highways, where speeds are greater and where the vast majority of traffic is not CBM related. Nevertheless, an increase in CBM traffic would occur on these roads, as well, and a minimal increase in vehicle collisions may occur. The increase in traffic would be directly correlated with the number of new wells; therefore, alternatives with a higher number of wells, such as Alternatives 1 and 2, have a greater potential to increase vehicle collisions than alternatives with a lower number of wells.

3.9.4.4 Habitat Fragmentation

The definition of fragmentation varies greatly within the literature. Fragmentation can refer to many varying aspects of change in the environment. These factors can range from naturally occurring change such as fire and insect outbreak to land uses such as timber sales and road construction. In this analysis, we refer to fragmentation as the change in spatial relationship of habitat components resulting from project activities as it affects habitat connectivity. Other components of fragmentation identified within the literature include direct habitat loss, displacement, vulnerability to predators, edge effects, vehicle collisions, etc. (Knight et al. 2000, Debinski and Holt 2000, Van Dyke and Klein 1996, Trombulak and Frissell 2000, Reed et al. 1996, Fahrig 2003, Forman and Alexander 1998). Various impacts associated with the term fragmentation are addressed individually within the analysis instead of under the one catch phrase of "fragmentation". This allows a closer examination of how these components relate to and affect the limiting factors of the species analyzed.

Construction and operation of project-related facilities would result in the fragmentation of wildlife habitats in the Project Area and on NFS land. Fragmentation would occur through loss of narrow strips along roads and small patches at well pad and facility sites. The extent of this fragmentation is substantially different from the type of fragmentation that has been studied extensively in other

areas: habitat loss would occur as narrow strips and small patches within a largely unaffected matrix, as opposed to widespread habitat loss with a few, small remaining patches of unaffected habitat. Much of the research in the Pacific Northwest and elsewhere was conducted on ecosystems that differ from those in the Southern Rocky Mountains, affecting how results can be extrapolated from there to here. Rocky Mountain forests are naturally patchy, influenced strongly by episodic disturbance, especially fire, and disturbances generally at different scales that more represent perforations than larger patches and islands within a more uniform vegetation (Knight et al. 2000).

The effects of habitat fragmentation would vary by wildlife species. For some, such as those that are small and less mobile (e.g., rodents, reptiles, and amphibians) fragmentation may disrupt movement and reduce connectivity between individuals or populations. For other species, such as those that readily cross the relatively narrow CBM access roads (e.g., bear and mountain lion), the type and extent of fragmentation anticipated with this project would be minor.

Agriculture and rural development have caused extensive fragmentation of habitats in the western two-thirds of the Project Area, and minor fragmentation in the Project Area's eastern third. The fragmentation anticipated to result from each of the alternatives would increase the cumulative amount of habitat fragmentation in the Project Area minimally because of the pattern of fragmentation anticipated and the relatively small amounts of habitats that would be affected.

3.9.4.5 Duration of Impacts

While adverse impacts associated with gas development may be moderate and long term, they should not be permanent. In 30 years, or less, all gas well and the vast majority of access roads would be removed and the areas reclaimed. The year round operational activities associated with the gas facilities would cease and wildlife would return to former use patterns. As the gas field develops, technologies that accelerate gas recovery could be used to compress the timeframes that wildlife are potentially affected by gas development.

3.9.5 Important Game Species

The impact of CBM development to important game species was an issue of widespread concern in scoping. Game species of concern identified in scoping include black bear, Merriam's wild turkey, elk, and deer, which are discussed in Section 3.9.6 and Appendix J.

3.9.6 Management Indicator Species

MIS are those species selected to function as a "bellwether" for other species that have the same habitat needs or similar population characteristics, and whose status generally can be ascertained and/or monitored through habitat and/or population information. Species are generally selected as MIS because their population changes are believed to indicate the effects of management activities (36 CFR 219.19 (a) (1)). For the purpose of assessing the effects of the alternatives on wildlife populations, the FS has designated MIS. Twenty-four wildlife

species are analyzed as MIS to evaluate the alternatives. An analysis of each of these species is presented in Appendix J. The depth of analysis is dependent on a number of factors including species or habitat presence in the Project Area and the magnitude of cause and effect to the species from the proposed actions. Bonytail, brook trout, Canada lynx, Columbian sharp-tailed grouse, humpback chub, northern river otter, and Uncompahgre fritillary butterfly do not occur within or have habitat within the Project Area on NFS lands and are not analyzed in detail in Appendix J. Species within and/or which have habitat present on NFS lands in the Project Area but not affected by the alternatives includes the American marten which is also not analyzed in detail within Appendix J. The following discussion of baseline information, concerns, effects of CBM development to date, and effects of the alternatives is summarized from the MIS analysis (Appendix J) and other appendices as referenced.

3.9.6.1 Affected Environment

The MIS addressed in this analysis are MIS species listed in the Forest Plan (Table 3-86). The MIS represent larger groups of species that are grouped into three categories: early-, mid-, and late-successional species. Early successional species, such as mountain bluebird, pocket gophers, and voles, are associated with the early stages of vegetation development (dominated by grass, forbs, shrubs, and tree seedlings) where suitable cover is available. Mid-successional species, such as green-tailed towhee and warbling vireo, thrive in young (dominated by pole-sized trees), forest environments. Late successional species, such as Abert's squirrel, hairy woodpecker, and flammulated owl thrive in mature and late successional forests where they find adequate food and cover. Many species, such as blue grouse, Steller's jay, mule deer, and elk, are associated with a variety of habitats and successional stages for food and cover, and are considered habitat generalists.

The quantity and quality of habitats for MIS were estimated by evaluating wildlife HSS matrices as described by Towry (1984) and by using professional judgment based on field reconnaissance. Table 3-87 shows the acreage and proportion of suitable habitats for each MIS species on NFS lands in the Project Area.

3.9.6.2 Environmental Consequences

MIS can be impacted by loss of habitat, loss of habitat effectiveness (through impacts such as increased road density, hunting pressure/harassment, and displacement), vehicle collisions, and habitat fragmentation, and by the cumulative effects of the proposed project and other past, present, and reasonably foreseeable activities. Each of these potential impacts is evaluated in detail in the individual MIS sections of Appendix J.

3.9.6.2.1 Direct Habitat Loss

Direct loss of MIS habitat would occur under each alternative during the construction phase of the project, because of road, well pad, and other facility construction. Habitat loss would reduce available forage and habitat components in the affected area. Habitats next to those directly disturbed may be degraded by changes in vegetation, including the invasion of noxious weeds.

Table 3-86 Forest Plan MIS (San Juan MIS Assessment)

Species Common Name	Scientific Name	PETS Status
Mammals		
Abert's Squirrel	*Sciurus aberti*	
American Marten	*Martes americana*	Region 2 Sensitive
Beaver	*Castor canadensis*	
Black Bear	*Ursus americanus*	
Canada Lynx	*Lynx canadensis*	Federal Threatened
Deer Mouse	*Peromyscus maniculatus*	
Elk	*Cervus elaphus*	
Mule Deer	*Odocoileus hemionus*	
Northern River Otter	*Lontra canadensis*	
Birds		
Bald Eagle	*Haliaeetus leucocephalus*	Federal Threatened
Columbian Sharp-tailed Grouse	*Tympanuchus phasianellus columbianus*	Region 2 Sensitive
Green-tailed Towhee	*Pipilo chlorurus*	
Hairy Woodpecker	*Picoides villosus*	
Mallard	*Anas platyrhynchos*	
Merriam's Turkey	*Meleagris gallopavo merriami*	
Mexican Spotted Owl	*Strix occidentalis lucida*	Federal Threatened
Mountain Bluebird	*Sialia currucoides*	
Northern Goshawk	*Accipiter gentilis*	Region 2 Sensitive
SW Willow Flycatcher	*Empidonax trailii extimus*	Federal Endangered
Invertebrates		
Uncompahgre Fritillary Butterfly	*Boloria acrocnema*	Federal Endangered
Fish		
Brook Trout	*Salvelinus fontinalis*	
Brown Trout	*Salmo trutta*	
Cutthroat Trout	*Oncorhynchus clarki* spp	Colorado River subspecies Region 2 Sensitive
Rainbow Trout	*Oncorhynchus mykiss*	

The direct loss of MIS habitat is a function of the number of wells, roads, and other facilities constructed under each of the alternatives. Alternative 2 would cause the largest habitat loss, followed in descending order by Alternatives 1, 7, 6, and 5. Certain habitat types would be affected more than others (Table 3-88) but, overall, there would not be a direct loss of habitat in excess of 4-percent for any species on NFS lands in the Project Area as a result of new CBM development (Table 3-89).

Most of the new habitat impact would be on national forest in the HD Mountains, because it is currently the least developed and would experience the most new development. The Project Area west side is extensively developed as agricultural and residential land and has experienced the most CBM development to date. Future CBM development on the west side of the Project Area would add a small increment of direct habitat loss to the landscape. To partially offset this impact, unused portions of well sites would be restored during the production phase. At the end of the production phase, all facilities would be removed and disturbed areas restored.

Table 3-87 Extent and Proportion of NFS Land in the Project Area Providing Habitats for Management Indicator Species

Species	Preferred Habitats	Habitats on NFS Land (acres)	Portion of NFS land (percent)
Abert's squirrel	Mid- and late-successional ponderosa pine habitat.	17,822	36
Bald eagle	Mature forest associated with large bodies of water	716	1
Beaver	Aquatic, riparian, and aspen	51	<1
Black bear	All forested types, grassland, riparian, Gambel oak, mountain shrub, aspen, and piñon-juniper	44,848	91
Brown trout	All rivers and creeks within the Project Area may contain suitable habitat, including the Piedra, Pine, Animas, and Florida Rivers.	4.3[1]	NA
Deer mouse	Early-successional habitats and mature open stands of aspen and warm-dry mixed conifer	49,085	99
Elk	All early-, mid-, and late-successional habitats. The Project Area provides important winter range.	49,324	99
Green-tailed towhee	Early- and mid-successional habitats, in sagebrush, Gambel oak, and mountain shrub.	33,036	67
Hairy woodpecker	Mid- and late-successional ponderosa pine, aspen, and mixed conifer with large snags for cavity nesting.	25,315	51
Mallard	Aquatic and riparian	51	<1
Merriam's turkey	Grasslands, riparian, Gambel oak, mountain shrub, aspen, piñon-juniper, ponderosa pine, and mixed conifer	41,175	83
Mexican spotted owl	Mature ponderosa pine and mixed conifer in canyons	1,980	4
Mountain bluebird	Early-, mid-, and late-successional habitats including sagebrush, mountain shrub, Gambel oak, piñon-juniper, riparian, aspen, and ponderosa pine. Depends on snags for cavity nesting. May also nest in live trees if a suitable cavity is available.	20,402	41
Mule deer	All early-, mid-, and late-successional habitats. Project Area provides important winter range.	49,324	99
Northern goshawk	Aquatic and riparian	11,447	23
SW willow flycatcher	Riparian shrub	0	0

Note:
1. Miles of perennial streams on NFS lands within the Project Area that are known to support or may support brown trout.

Table 3-88 Amount of Habitat Available and Affected by each Alternative for each MIS on NFS Land in the Project Area

MIS	Habitats Available (acres)	Habitats Affected by Alternative (acres)				
		1	2	5	6	7
Abert's squirrel	17,822	313	452	69	152	213
Bald eagle	716	23	23	0	0	23
Beaver	51	0	0	0	0	0
Black bear	44,848	409	755	59	166	277
Brown trout	4.3[1]	0	0	0	0	0
Deer mouse	49,085	698	1,116	109	316	497
Elk	49,324	494	723	90	223	354
Green-tailed towhee	33,036	409	755	59	166	277
Hairy woodpecker	25,315	403	599	78	181	280
Mallard	51	0	0	0	0	0
Merriam's turkey	17,822	578	952	93	259	388
Mexican spotted owl	1,980	–[2]	–	–	–	–
Mountain bluebird	20,402	289	488	56	158	234
Mule deer	49,324	494	723	90	223	354
Northern goshawk	11,447	225	250	40	108	158
SW willow flycatcher[3]	0	0	0	0	0	0

Notes:

1. Miles of perennial streams in the Project Area that Are known to support or may support brown trout.
2. Acres affected under any of the alternatives are minor to non-existent and considered insignificant and discountable in effects. See individual species analysis in Appendix H and J.
3. No habitat identified. See analysis section for the species.

Table 3-89 Proportion of Habitat Available and Affected by each Alternative for each MIS on NFS Land in the Project Area

MIS	Habitats Available (percent)	Habitats Affected by Alternative (percent)				
		1	2	5	6	7
Abert's squirrel	36	1.8	2.5	0.4	0.8	1.2
Bald eagle	1	3.2	3.2	0.0	0.0	3.2
Beaver	<1	0.0	0.0	0.0	0.0	0.0
Black bear	91	1.4	2.3	0.2	0.6	0.9
Deer mouse	99	1.4	2.3	0.2	0.6	1.0
Elk	99	1.6	2.3	0.3	0.7	1.1
Green-tailed towhee	67	1.2	2.3	0.2	0.5	0.8
Hairy woodpecker	51	1.6	2.4	0.3	0.7	1.1
Mallard	<1	0.0	0.0	0.0	0.0	0.0
Merriam's turkey	36	3.2	5.3	0.5	1.5	2.2
Mexican spotted owl	4	–[1]	–	–	–	–
Mountain bluebird	41	1.4	3.9	1.1	1.4	2.0
Mule deer	99	1.6	2.3	0.3	0.7	1.1

Note:

1. Acres affected under any of the alternatives are minor to non-existent and considered insignificant and discountable in effects. See individual species analysis in Appendix H and J.

The time period that impacted land would be unsuitable as wildlife habitat is variable and would depend on well lifespan, restoration techniques and success, and local weather. But generally, restoration of habitats dominated by grasses and forbs should be successful within several years. Where the goal is to restore habitats dominated by shrubs and trees, re-growth of young stands to those mature structural stages may take decades or more. Consequently, the disturbance of forest and shrub habitats would represent a long-term impact beyond the end of the production phase to those species that depend on such vegetation for forage or shelter. A small portion of the roads constructed for gas field development would not be reclaimed, but would be maintained as part of the permanent road system, resulting in permanent loss of wildlife habitats. Conversely, some existing roads in the National Forest portion of the Project Area have been removed from the permanent road system and would revert to suitable habitat conditions over time.

3.9.6.2.2 Habitat Effectiveness

The scientific literature supports quantitative analysis of habitat effectiveness impacts for elk and mule deer. For the remainder of species analyzed in this EIS, surrounding habitat that is directly disturbed would be reduced in habitat effectiveness, but the extent of that area is not well known or defined by scientific study.

In response to increased human activity, equipment operation, vehicular traffic, and noise associated with all phases of gas field development and operation, wildlife may avoid these activities and prefer other locations. This avoidance would result in the under-utilization of otherwise suitable habitats; therefore, the effectiveness of these habitats in supporting wildlife would be diminished. Similarly, the displacement of wildlife from disturbed areas may lead to the overuse of suitable habitats in undisturbed areas, increasing competition for limited resources. Wildlife distribution patterns would be altered. The degree of habitat avoidance would vary between species and among individuals of any particular species. Development would not occur in a manner that affects only certain, isolated parts of the Project Area at a particular time. For this reason, no attempt has been made to predict temporal patterns of loss of habitat by affected wildlife. Alternative 2 would cause the greatest loss of habitat effectiveness, and thus capacity to support MIS, followed in descending order by Alternatives 1, 7, 6, and 5.

3.9.6.2.3 Habitat Trend

Each alternative would result in a slight loss of habitat for most species. The amount of habitat for each MIS that is available and that would be impacted in the Project Area under each alternative is shown on Table 3-88. The proportion of habitat that is suitable for each MIS, and the proportion of suitable habitats that would be lost on NFS land in the Project Area under each alternative, are shown on Table 3-89.

The MIS analysis also concerns habitat trend over the SJNF and the relationship of project-level impacts to overall Forest trends for MIS species. Table 3-90 describes the Forest-wide habitat trend for the selected MIS (SJNF MIS Assess-

ment unpublished report). The project would not contribute appreciably to a change in this habitat trend.

Table 3-90 MIS Habitat Trends (SJNF MIS Assessment)

MIS	Current Trend	Future Trend
Abert's squirrel	Stable	Same
Bald eagle	Stable	Same
Beaver	Slightly upward	Slightly upward to stable
Black bear	Stable	Same
Brown trout	Decreasing	Same
Deer mouse	Stable to slight upward (but variable)	Same
Elk	Slight downward	Same
Green-tailed towhee	Slight upward	Same
Hairy woodpecker	Slight upward	Same
Mallard	Slight upward	Slight upward
Merriam's turkey	Stable	Same
Mexican spotted owl	Stable	Same
Mountain bluebird	Stable	Same
Mule deer	Decreasing	Same
Northern goshawk	Stable to slight downward	Stable to slight upward
SW willow flycatcher	Stable to slight upward	Same

3.9.6.2.4 Population Trend

Reduced population is generally a concern if a substantial proportion of available habitats is lost or reduced in effectiveness for a long period. Substantial losses of habitat are not predicted for any of the alternatives on NFS land, or in the Project Area (Table 3-88). On private lands, there may be reduced population levels in the Project Area's west side, where residential development has accelerated over the past decade.

Population trend for each MIS has been analyzed accounting for other limiting factors that may affect MIS populations. This analysis follows the conceptual framework presented by Ruggiero et al. (1994), using knowledge of a species' ecology to examine the effects of management actions on the species' habitats and population biology. The outcome is an informed judgment of the effects of the management action on population trend at the Forest level (Ruggiero et al. 1994). Conclusions, based on the SJNF forest-wide MIS assessment and the results of this project assessment (Appendix J), are shown in Table 3-91.

3.9.6.3 Cumulative Effects

The cumulative effects analysis area is defined as the Project Area (125,348 acres) and that area within the bounds of the Southern Ute Indian Reservation that has and would continue to experience oil and gas development (421,300 acres). CBM development within the exterior bounds of the Southern Ute Reservation was recently studied in an EIS completed in October 2002 (BLM et al. 2002). The findings of that EIS are incorporated in the wildlife cumulative effects analysis resulting in a cumulative effects analysis area of 547,000 acres. The quantitative analysis is limited to oil and gas development,

which is quantified for the entire cumulative effects analysis area. Other activities that would affect MIS such as residential development are assessed qualitatively because of lack of quantitative data that would define the magnitude of these components of impact. Additional background information and details on cumulative effects are discussed in the MIS analysis (Appendix J).

Table 3-91 MIS Population Trends (SJNF MIS Assessment)

MIS	Current Trend	Predicted Future Trend
Abert's squirrel	Stable	Stable or slightly decreasing
Bald eagle	Slight upward (but variable)	Same
Beaver	Upward	Upward to stable
Black bear	Stable (but variable): to slight down on east SJNF to slight up on west SJNF	Stable
Brown trout	Decreasing	Stable or Decreasing
Deer mouse	Stable to slight upward (but variable)	Same
Elk	Stable	Stable to Decreasing
Green-tailed towhee	Stable	Stable or slightly increasing
Hairy woodpecker	Stable	Stable or slightly decreasing
Mallard	Stable to slight upward	Stable to slight upward
Merriam's turkey	Upward	Same
Mexican spotted owl	No trend as there are only isolated occurrences and no populations	Same
Mountain bluebird	Stable	Stable or slightly increasing
Mule deer	Stable (but variable)	Stable (but variable)
Northern goshawk	Stable to slightly downward	Same
SW willow flycatcher	No trend as there are only isolated occurrences and no populations.	Same

Within the cumulative effects area, no more than 6 percent of suitable habitat for any MIS would be directly affected by CBM development (Table 3-92 and Table 3-93). CBM development should affect individuals but not impact forest-wide population trends of MIS (Appendix J). Of greater concern is the loss of habitat effectiveness and displacement that would occur because of continued residential and CBM development within the Project Area's west side. Residential development would be more pervasive in its effect, whereas CBM roads and faculties would be closed and gated to reduce wildlife-human conflict. Big game would be the species most affected by continued residential development (Appendix J).

3.9.6.4 Mitigation and Monitoring

The following mitigation measures are recommended, in addition to general mitigation measures presented in Section 3.9.3, for individual MIS species and the wildlife they represent. Unless otherwise stated, the following measures would be funded by the companies.

Table 3-92 Extent of Direct Cumulative Loss of MIS Habitats from Oil and Gas Development in Cumulative Effects Analysis Area

MIS Analyzed in Detail	Habitats Available (acres)	Habitats Affected by Alternative (acres)				
		1	2	5	6	7
Abert's squirrel	58,860	1,691	1,829	1,401	1,469	1,592
Bald eagle	27,500	820	863	802	802	820
Beaver	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]
Black Bear	291,878	12,841	13,447	12,523	12,569	12,260
Elk	468,431	24,485	25,168	23,821	24,014	24,273
Green-tailed towhee	279,092	17,957	18,476	17,592	17,707	17,825
Hairy woodpecker	227,663	4,542	4,375	4,182	4,267	4,421
Mallard	–[1]	–[1]	–[1]	–[1]	–[1]	–[1]
Merriam's Turkey	440,800	20,425	21,030	19,904	20,052	20,238
Mexican Spotted Owl	57,980	–[2]	–[2]	–[2]	–[2]	–[2]
Mountain bluebird	415,931	9,049	9,398	8,808	8,873	8,949
Mule deer	468,430	20,085	19,996	19,771	20,706	19,838
Northern Goshawk	46,350	1,591	1,675	1,362	1,410	1,523
SW Willow Flycatcher	534	0	0	0	0	0

Note:
1. Quantitative values not available.
2. Acres affected under any of the alternatives are minor to non-existent and considered insignificant and discountable in effects. See individual species analysis in Appendices H and J.

Table 3-93 Proportion of Cumulative Loss of MIS Habitats Available from Oil and Gas Development in Cumulative Effects Analysis Area

MIS	Habitats Available (percent)	Habitats Affected by Alternative (percent)				
		1	2	5	6	7
Abert's squirrel	11	2.9	3.1	2.4	2.5	2.7
Bald eagle	5	3.0	3.1	2.9	2.9	3.0
Beaver	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]
Black Bear	51	2.3	2.4	2.2	2.2	2.3
Deer Mouse	88	5.1	5.2	5	5	5.1
Elk	86	5	5	5	5	5
Green-tailed towhee	66	6.4	6.6	6.3	6.3	6.4
Hairy woodpecker	42	2.0	2.1	1.8	1.9	1.9
Mallard	–[a]	–[a]	–[a]	–[a]	–[a]	–[a]
Merriam's Turkey	81	4.7	4.9	4.3	4.4	4.4
Mexican Spotted Owl	13[b]	<1	<1	<1	<1	<1
Mountain bluebird	76	2.2	22	2.1	2.1	2.1
Mule deer	86	4	4	4	4	4
Northern Goshawk	8	3.4	3.6	2.9	3.0	3.1
SW Willow Flycatcher	<1	0	0	0	0	0

Note:
a. Quantitative values not available.
b. The cumulative effects area for the spotted owl on the SUIT study area could only be loosely defined as mixed conifer and ponderosa pine. Data for the more refined definition of habitat as used for the Project Area is unavailable from the Tribe. See species analysis in Appendix H.

3.9.6.4.1 Abert's Squirrel

- Minimize impacts to squirrel nesting habitat to the extent practical in consideration of other wildlife species. This may include relocating proposed development or modifying vegetation treatment to maintain identified nesting condition where practical. This is expected to effectively maintain squirrel nesting-habitat components within the analysis area and meet standards and guidelines found in Forest Plan direction.

3.9.6.4.2 Elk and Deer

- Where possible, select non-critical and lower use wildlife habitats over critical, important, and high use habitats. One possible means is to use directional drilling methods.
- Minimize fencing. However, where necessary, install fencing that reduces wildlife mortality and reduces restrictions to movement while meeting other objectives. There are many designs available to address different issues in differing situations. The intent is to utilize wildlife friendly designs when fencing must be used to control livestock movement or protect other resource values.
- Where practical, avoid creating disturbance in sagebrush habitat so as to minimize mule deer winter range impacts.
- Elk and Deer Habitat Mitigation Measure: Every five years, unless otherwise determined by the Authorized Officer, operators conducting oil and gas activities in the NSJB EIS project area will complete elk and deer habitat enhancement project(s). The project(s) must enhance acreage in elk habitat or deer winter range in the Project Area, preferably on state or federal lands in an amount that is equal or greater to the acreage disturbed in elk habitat or deer winter range by oil and gas activities in the NSJB EIS Project Area. Each operator is responsible to enhance acreage equal or greater to disturbed acreage created under their respective permits, but can plan and implement enhancement projects of any size, either individually, collectively, or in cooperation with local, state, and/or federal agencies. Enhancement projects designed to meet the requirements of this mitigation measure must be reviewed and accepted by the BLM/FS Authorized Officer. This measure would provide effective mitigation for impacts to elk habitat and deer winter range by ensuring that habitat losses are offset by habitat enhancement, and by providing up-front incentive for operators to minimize disturbance when conducting oil and gas activities in elk habitat or deer winter range. In addition, operators in the Project Area are encouraged to enhance additional acreage above this minimum requirement whenever possible because the actual impact area is larger than the direct disturbance area. Based on accepted scientific principles and as described in the NSJB FEIS wildlife analysis, indirect effects to elk habitat and deer winter range can extend up to .25 miles from CBM facilities and roads. The magnitude of this indirect impact is not quantifiable at this time, so operators are also encouraged to participate in current and future research efforts designed to better define these indirect impacts.

3.9.6.4.3 Green-tailed Towhee

No additional mitigation measures are proposed for this species.

3.9.6.4.4 Hairy Woodpecker and Bluebird

- Where possible, protect all large-diameter (greater than 16 inches d.b.h.) standing snags from loss to construction activities, especially in ponderosa pine stands. Where no large-diameter snags exist, protect all snags in the largest 10 percent of the stand's diameter class. Preference for large-diameter snags or the largest diameter available has been well documented for many cavity constructor species. This mitigation would minimize the loss of snags thereby reducing impacts to snag-dependant wildlife. Snag protection measures are expected to maintain average snag densities and distributions within the overall Project Area.
- Inventory for and, where possible, protect all nest cavity trees from loss to construction activities, especially in ponderosa pine stands. Inventories shall occur no more than 1 year prior to construction or other intrusive activities and preferably within the same calendar year as the project activity. Studies have shown a preference for ponderosa pine by cavity constructor species. Because cavity trees are used consistently for many years, this protection measure is expected to be an effective tool for minimizing the impact of project implementation on cavity-dependent wildlife while maintaining actively used nest cavity sites.
- Protect as many large-diameter (greater than 16 inches d.b.h.) live trees with defects as possible to serve as replacement snags, especially those trees with heartwood decay, spike-topped trees, broken-topped trees, and hollow trees. Preference for large-diameter snags has been well documented for many cavity constructor species. This mitigation is expected to maintain live snag-replacement trees of sufficient diameter within the Project Area to maintain long-term habitat value for snag-dependant wildlife.
- Prohibit cutting of standing dead ponderosa pine on National Forest and BLM lands in the Project Area for personal use firewood. This measure would be implemented by the FS and is designed to protect snags for cavity-dependent wildlife species.

3.9.6.4.5 Black Bear

- If an active black bear den is discovered adjacent to a new road, well pad, or other infrastructure, stop construction activities and notify the Authorized Officer. This mitigation would effectively protect the bear and its den from harm.
- To the extent practical, avoid facility construction on or adjacent to (within 150 feet) large diameter (greater than 3 inches) Gambel oak stands. These oak stands are the primary producers of acorns, a key autumn food source for bear. This mitigation would be effective in minimizing loss of Gambel oak stands in most cases. There are well spacing limits consistent with the existing regulations and terrain features that may reduce the ability in some cases to avoid construction in large diameter Gambel oak.

3.9.6.4.6 Turkey

- Avoid destruction of known active roost trees by surveying potential habitat prior to removing vegetation with heavy equipment. Survey areas within 200 meters of proposed construction activities. Surveys should be conducted no more than 1-year prior to construction activities. If possible, limit the ex-

tent of vegetation clearing by buffering known roost trees by 150 feet beyond the outermost roost trees (Wait 2002). All trees within roost sites should be protected regardless of size. This measure would effectively protect turkey roost trees.

- To the extent practical, avoid construction on or adjacent to (within 150 feet) roosting habitat. Preferred sites have the following characteristics: on slopes sheltered from the wind with easterly aspects, within ½ mile of water, and with a minimum of ground cover. Large trees with open branches and open crowns are optimal, especially if they are ponderosa pine trees. This measure would effectively minimize roost habitat impact in most cases. There are well spacing requirements that may reduce the ability in some cases to avoid construction in roost tree habitat.
- To the degree possible, retain large diameter Gambel oak clumps that are greater than 3 inches in diameter. These trees provide acorns for turkey. There are limits on how far a well may be moved consistent with the existing spacing orders that may reduce the ability in some cases to avoid construction in large diameter Gambel oak.
- Wherever possible, prevent construction of new roads and other project infrastructure from meadows and openings. This criterion is most important in turkey winter range areas and along Ignacio Creek. This measure would be effective in minimizing effects of habitat loss in most cases. There are distance limits consistent with the existing well spacing orders that may reduce the ability in some cases to avoid construction in meadows and openings.
- Within turkey winter range, when conducting partial or permanent site rehabilitation, consider using a species mix that includes native species comprised of 50 percent large seeded grasses and 50 percent forbs, of which 20 percent should be legumes. It is believed this mitigation would be effective for providing feeding habitat in the long term for turkeys. Inspect seeding revegetation success and replant as necessary and as climatic conditions permit.

3.9.6.4.7 Goshawk

- Inventory for and prohibit construction activities within ¼ mile of any active goshawk nest between April 1 and August 15. Inventories shall occur no more than 1 year prior to construction or other intrusive activities and preferably within the same calendar year as the project activity. This mitigation has been effective in protecting active raptor nests when applied to disturbance activities similar to those associated with CBM development.
- Inventory for goshawk nest structures and relocate construction activities to avoid a 30-acre area surrounding active or vacant alternate goshawk nest sites. There is indication this mitigation will protect sufficient nesting habitat characteristics for the site to remain effective

3.9.6.4.8 Bald Eagle

The following conservation measures were developed in partnership with the USFWS, and was the basis for a determination of "may affect but not likely to adversely affect" for the proposed project. The companies have agreed to implement the measure on federal and non-federal lands development.

- Conduct surveys of nesting and potential roosting areas during appropriate seasons each year to determine if nest and roosting sites are active before site-specific project activities begin. Surveys shall occur no more than 1-year prior to construction or other intrusive activities and preferably within the same calendar year as the project activity. Times and locations for these surveys shall be established in consultation with the Authorized Officer
- Construct well pads, compressor stations, and ROWs at least ¼ mile from bald eagle nests and active winter roosts. Year-round closure to surface occupancy (i.e., temporary or permanent structures), beyond that which historically occurred in the area, within ¼ mile of nest sites (active or inactive).
- Restrict activities within ½ mile of bald eagle nests between January 1 and July 31, unless the nest is documented to be vacant during that season. Inventories shall occur no more than 1 year prior to construction or other intrusive activities and preferably within the same calendar year as the project activity. Only activities reviewed and approved by the Authorized Officer can occur.
- No activities shall take place within bald eagle winter concentration areas between November 15 and March 15 unless approved in writing by the Authorized Officer. If the Authorized Officer approves activities, such as routine well maintenance, within bald eagle winter concentration areas between November 15 and March 15, it shall be restricted to a period between 9:00 a.m. and 2:00 p.m.
- Emergency work-overs that are necessary and proposed to take place between November 15 and March 15 in bald eagle winter concentration areas, such as replacing/repairing pumps, clearing plugged tubing, swabbing or associated operations to unload fluids from a well, repairing a hole in the tubing, or repairing a well bore and/or surface equipment in order to ensure environmental protection will be approved by the Authorized Officer. These activities are limited to daylight hours between 9:00 a.m. and 2:00 p.m. only and will be of short duration.
- Avoid removal of large cottonwood, ponderosa pine, or other potential roost and nest trees within bald eagle winter concentration areas, winter roosts, and areas that may provide nesting habitat.
- Avoid construction of aboveground power lines. However, if construction of aboveground power lines is approved by the Authorized Officer, use raptor protection measures (Avian Power Line Interaction Committee [APLIC] 1994, APLIC 1996) that are designed to reduce the potential for avian collision and electrocution.

3.9.6.4.9 Mexican Spotted Owl

- Implement Mexican spotted owl management guidelines according to the Mexican Spotted Owl (MSO) Recovery Plan should any breeding or resident owls be discovered in the Project Area (USFWS 1995a). This conservation measure was developed in partnership with the USFWS and is required to support a determination of "may affect but not likely to adversely affect" for the proposed project. The companies have agreed to implement the measure on Federal and non-Federal lands development.

3.9.6.4.10 Southwestern Willow Flycatcher

- The possibility that Southwestern Willow Flycatcher (SWWF) habitat may be discovered in the Project Area during project implementation due to mapping limitations makes it reasonable and prudent to apply the following mitigation measures in the event that SWWF habitat is located in the Project Area. The following conservation measures were developed in partnership with the USFWS, and was the basis for a determination of "may affect but not likely to adversely affect" for the proposed project. This includes implementing the guidelines of the 2003 (or current) Southwestern Willow Flycatcher Recovery Plan. The companies have agreed to implement these conservation measures on federal and non-federal lands development.
- Conduct pre-project inventories for the presence of suitable southwestern willow flycatcher habitat within close proximity of proposed work areas. Habitat inventories shall occur no more than 2 years prior to construction or other intrusive activities.
- If suitable flycatcher habitat is found in proximity to project work areas (within 200 meters), conduct surveys for the southwestern willow flycatcher during the pre-construction phase. Surveys shall occur no more than 2 years prior to construction or other intrusive activities. Times and location of surveys shall be established in consultation with the Authorized Officer (breeding surveys will occur between May 15 and July 20, and will be in accordance with the latest USFWS protocol). In the absence of completed and approved surveys, all suitable southwestern willow flycatcher habitats shall be assumed to be occupied.
- Prohibit disturbance to occupied southwestern willow flycatcher habitat by sighting facilities a minimum of 100 meters away from such habitat. If birds are located during survey efforts, no surface disturbing activities would be conducted from May 1 to August 15.
- Avoid disturbance to suitable southwestern willow flycatcher habitat by sighting facilities a minimum of 100 meters away from such habitat.
- Minimize construction in wooded riparian habitats.
- BMPs for riparian/wetland areas would be implemented to avoid adverse impacts to these habitats.

3.9.6.4.11 Brown Trout

- Due to the low threat to brown trout populations, population monitoring is not recommended. Implementation and effectiveness monitoring of watershed and soil BMPs is strongly recommended. Validation of the "3M" model used to predict water consumption is also recommended.

3.9.6.5 Monitoring

Ongoing monitoring conducted in the HD Mountains is two pronged in terms of objectives. First, compliance monitoring would be conducted through the life of the project to determine and maintain project compliance with the mitigation requirements set forth above and elsewhere in Chapter 2, particularly public compliance with road closures and travel management restrictions, industry compliance with surface use mitigation required as APD conditions of approval, and compliance with rehabilitation and weed control requirements.

Second, the FS has conducted inventories and monitoring for selected wildlife species in 2002, 2003, 2004, and 2005 to establish pre-project baseline conditions. Species inventoried and monitored include Abert's squirrel, green-tailed towhee, hairy woodpecker, Merriam's turkey, mountain bluebird, and northern goshawk. The FS, in addition, has consulted with the Colorado Division of Wildlife (CDOW) on available inventory, monitoring, and/or species status information for Abert's squirrel, brown trout, elk, and mule deer. The BLM in cooperation with the SUIT, CDOW, and the Department of Energy is gathering pre-project baseline condition information for mule deer to monitor effects to the species.

The FS would continue monitoring these wildlife species. Unless otherwise stated, the following measures would be funded by the companies. Monitoring of Abert's squirrel and northern goshawk would continue annually or every other year to validate predicted long-term species impacts within the Project Area. Monitoring of green-tailed towhee, hairy woodpecker, and mountain bluebird would occur on an annual basis for at least the first two years of project construction, and every five years thereafter. Monitoring would provide data to assess mitigation effectiveness, species response to project implementation, and compliance with LRMP standards and guidelines. Monitoring would also contribute information to overall population and habitat trend monitoring occurring simultaneously across the SJNF.

The FS would continue intra-agency coordination with the CDOW to obtain available monitoring or status information on, brown trout, elk, and mule deer within the Project Area and across the SJNF. As with the other MIS, effectiveness monitoring of mitigation measures recommended for game species would be conducted to determine effectiveness, and need for change.

Snag surveys are recommended around project infrastructure facilities (well pads, compressor stations, primary roads, spur roads, etc.) as well as away from project roads and infrastructure to monitor compliance with LRMP snag density standards and guidelines. Surveys would quantify the number, diameter, condition class and density of snags and specifically target ponderosa pine stands as well as the density of trees larger than 16 inches d.b.h. Surveys at infrastructure sites should be conducted prior to construction activities within areas to be cleared to gauge the impacts of project implementation and the relationship to LRMP standards and guidelines.

3.9.6.6 Conformance to Existing Plans and Policies

The LRMP direction for wildlife consists of forest direction and management area direction (FS 1992). The forest direction details overall management requirements that are to be achieved or maintained across the SJNF over time. Management area direction presents more specific direction for areas of land on the SJNF called management areas. Management areas are zones within a larger landscape.

The following LRMP (FS 1992) direction and guidelines apply to NFS land within the Project Area.

3.9.6.6.1 Forest Direction

Maintain habitat for viable populations of all existing vertebrate wildlife species (FS 1992: III–26). The management guideline for this direction is to maintain habitat for each vertebrate species on the SJNF at least at 40 percent or more of potential.

3.9.6.6.2 Management Area Direction

Management direction for five management areas: 2B, 3A, 4B, 5B, and 6B apply to the Project Area. For vertebrate species, the 40-percent habitat potential guideline applies to management areas 2B, 3A and 5B (35,000 acres), a 60 percent habitat potential guideline applies to management area 6B (6,000 acres) and an 80-percent guideline applies to management area 4B (12,000 acres). Additionally an 80-percent guideline applies to deer and elk habitat in management area 5B.

The 4B management area is within the HD Mountains Roadless Area and has no prior history of timber management, or roading and has received light grazing over the past few decades. The 6B management area is in the Sauls Creek area and has a history of timber harvest and tree thinning that dates back to the 1940s. The 6B area emphasizes range management, and contains tree stands are mostly even-aged ponderosa pine, 12-inch average d.b.h. with a fairly closed canopy, well interspersed with meadows. The 6B area has also experienced CBM development beginning in the early 1990s. To determine whether the SJNF portion of the Project Area is currently meeting these standards, we reconstructed actions and trends that may have affected wildlife habitat potential.

The NFS portion of the Project Area has experienced changes in vegetative cover type and composition because of timber harvest, fire suppression, and grazing. Timber harvest has converted approximately 6,000 acres of old, large mature pine to younger, more uniform stands of saw timber sized stands in the Sauls Creek area and along the east flank of Pargin Mountain. Recorded timber harvest began on the 1940s. In addition, we suspect that there was much earlier harvest along the flanks of the HD Mountains due to settlement in and around La Plata County that removed the large tree component of many stands.

Fire suppression and grazing have contributed to the following trends: There is less grassland today than in the past due to slow encroachment of pinyon-juniper into grassland ecosystems. Similarly, there is less sagebrush meadow due to pinyon-juniper encroachment. The ongoing FS use of prescribed fire in these cover types has slowed this encroachment, however. Some ponderosa pine stands along the ecotone with mixed conifer have experienced slow encroachment of mixed conifer, which could also be reversed through prescribed fire management. Mixed conifer stands have become denser, and more dominated by white fir than in the past. Finally, aspen, Gambel oak and spruce-fir stands have continued to mature. The continued maturation of aspen could result in partial loss of its representation where stands are not self-regenerating.

In addition, portions of the HD Mountains have been roaded over time. Currently, about 28,000 acres of the 49,500-acre area remains unroaded. Many of the roads are closed to motorized vehicles providing for habitat security, but there is moderate use of the Sauls Creek road system during all seasons and moderate use of the entire area's roads by ATVs during hunting season. During winter, roads

are closed and snowed out. Many roads are also gated during the summer to restrict public use.

With these habitat changes and the limited wildlife-human interaction, the HD Mountains Area continues to provide habitat for vertebrate species at least at 40 percent of potential. The 12,000-acre 4B management area most likely also provides habitat at 80 percent of potential because it continues to remain unroaded, unlogged, lightly grazed, and isolated from recreational activities. The 6,000-acre 6B management area, located generally around Sauls Creek presents somewhat more of a complicated set of circumstances due to past harvest, roading and recreational use. The concern of the biologist team on the SJNF is that the area may not be meeting the 60-percent habitat potential guideline for hairy woodpecker, and bluebird and the other species they represent as MIS. There is concern that a lack of snags in Sauls Creek may adversely affect hairy woodpecker and bluebird habitat. Further field investigation would be conducted to determine whether the 6B area is currently meeting the 60-percent habitat potential guideline.

Each of the alternatives would affect habitat capability in different ways and in different areas. Alternative 2 would have the greatest impact, followed in descending order by Alternatives 1, 7, 6, and 5. The largest impact would be in the ponderosa pine habitat, resulting in approximately a 5 percent physical reduction in pine habitat in Alternative 2, and lesser impacts in the other alternatives. The physical habitat alteration and loss of habitat would not in itself result in a measurable change in habitat capability when compared to the current situation. In addition, the 4B management area would remain unroaded and undeveloped under Alternatives 1, 5, 6, and 7, maintaining that area at least at 80 percent of habitat capability. Alternative 2 would develop much of the 4B area and there would be a slight loss of habitat capability.

A change in road management would be implemented in Alternatives 1, 2, 6, and 7 to restrict on and off-road motorized travel to a few designated routes. All other routes would be closed to public use (see Recreation section of this chapter). This mitigation is designed to significantly reduce human-wildlife conflict and resultant loss in wildlife habitat capability. However, non-CBM related foot and horseback traffic during hunting season would seasonally reduce habitat capability across the entire HD Mountains area. With the change in road management, the same habitat conclusions would apply: The HD Mountains would continue to provide for 40 percent habitat capability under all alternatives. The 4B management area would continue to provide for 80-percent habitat capability in Alternatives 1, 5, 6, and 7, but would experience reduced capability in Alternative 2. The 6B management area would continue to provide for 60 percent of habitat capability for all alternatives, for all species, with the possible exception of hairy woodpecker, bluebird, and the species they represent. The 60 percent habitat capability standard can be maintained or promoted for these species through management that includes tree thinning and prescribed fire in the grassland, sagebrush, and pine types and prohibitions on standing dead tree harvest. These activities would be accomplished through wildlife habitat improvement projects.

3.9.6.6.3 Other Applicable LRMP Guidelines

Maintain one Abert's squirrel nest-tree clump (0.1 acre of 9-inches-to-22-inches-d.b.h. ponderosa pine with a basal area of 180 to 220 and an interlocking canopy) per two acres on all ponderosa pine sale areas (FS 1992: III–147). No systematic inventory data exist that show whether the SJNF is meeting this guideline. However, based on knowledge of pine forest characteristics in the Project Area, it is likely that the SJNF is meeting this guideline. The SJNF would continue to meet the guideline under all alternatives because only a small proportion of ponderosa pine habitats (0.5 to 5 percent) would be affected under each alternative.

For woodpecker and bluebird and the wildlife species they represent, protect and provide 25 snags/10 acres in forested types, also provide for snag replacement. Through on-site observations, we believe that the snag guideline is not being met in portions of the pine type, particularly in Sauls Creek. Further field investigation would be conducted to ascertain snag density. The alternatives would not contribute measurably to additional snag loss.

For big game, specifically deer and elk, provide for 80 percent habitat capability within 5B management areas. The 5B management areas specifically emphasize management for big game winter range. The guideline would be met in the 5B area under all the alternatives. The control of vehicular access during the winter months is prescribed to specifically maintain winter habitat capability for deer, elk, and other wildlife species in general.

Other LRMP guidelines apply to wildlife habitat structural improvements and/or habitat guidelines that would be maintained or accomplished through timber sales, and do not apply to this project.

3.9.7 Federally Listed Threatened and Endangered Species

The Biological Assessment (Appendix H) was prepared in accordance with the legal requirements set forth under Section 7(c) of the ESA, and FS and BLM Manual direction to address potential effects to listed species from the proposed project. This section summarizes Appendix H.

3.9.7.1 Affected Environment

The fish and wildlife species of concern are listed in the current Rocky Mountain Region endangered, threatened, proposed, and sensitive species list (FS 2001d). Based on a screening of the list, it was determined that four of these species are not expected to occur in the Project Area. Species thus eliminated from further evaluation include: Canada lynx, bonytail chub, humpback chub, and Uncompahgre fritillary butterfly. The specific rationale for each species' elimination is presented in Appendix H.

The remaining threatened and endangered species may occur in the Project Area. Table 3-94 shows their preferred habitats and the acreage and proportion of suitable habitats for each species in the Project Area. General information about each species is presented in Appendix H.

3.9.7.2 Environmental Consequences

The amount of habitat that is available for each species and that would be impacted under each alternative is shown on Table 3-95 for federally listed threatened and endangered species. The proportion of the Project Area that is suitable for each species and the proportion of suitable habitats that would be lost or impacted under each alternative are shown on Table 3-96. Each alternative would reduce available habitat for most species; however, the proportion of available habitats that would be lost is small.

The Proposed Action may affect but is not likely to adversely affect the bald eagle and bald eagle habitat in the Project Area. The Proposed Action would disturb 48 acres, or 0.4 percent, of the winter concentration areas in the Project Area. Cumulatively, the Proposed Action when combined with other CBM related activities in the cumulative impact analysis area would impact 826 acres (3 percent) of bald eagle winter concentration areas. Committed conservation measures would be implemented (Section 3.9.6.4) to avoid adverse effects to the bald eagle and bald eagle habitat.

Table 3-94 Extents and Proportion of Threatened and Endangered Species Habitats in the Project Area

Species	Preferred Habitats	Habitats in Project Area (acres)	Portion of Project Area (percent)
Bald eagle	Nests in large trees or snags near larger streams, rivers, lakes, and reservoirs. Winter roosts in timber stands usually near rivers or other water features. Forages widely, focused on open water and wetland areas, also in uplands.	11,553[1]	9
Mexican spotted owl	Associated with steep canyons and cliffs in or near mature forests of ponderosa pine and mixed conifer (especially Douglas-fir).	1,980	1.6
Southwestern willow flycatcher	Riparian habitats along rivers, streams, or other wetlands, with dense growths of willows and other shrubs, often with a scattered overstory of cottonwood; surface water or saturated soil is required.	534[2]	<1
Colorado pikeminnow and razorback sucker	Colorado pikeminnow: adults prefer deeper areas of river channels while first-year fish utilize quiet backwater areas and side channels. Razorback sucker: low runs, shallow to deep pools, backwaters, eddies, and other slow velocity areas with sandy substrates.	San Juan River[3]	0

Notes:
1. Winter Concentration Area. There are no designated winter roosts or nesting areas in the Project Area.
2. Includes 457 acres of suitable habitat and 67 acres of potential habitat.
3. Downstream of the Project Area.

Table 3-95 Amounts of Habitats Available and Affected by each Alternative for each Federally Listed Threatened and Endangered Species on All Lands in the Project Area

Species	Habitats Available (acres)	Habitats Affected by Alternative (acres) 1	2	5	6	7
Bald eagle	11,553	48	115	37		
Mexican spotted owl	1,980	-[a]	-[a]	-[a]	-[a]	-[a]
Southwestern willow flycatcher	534	0	0	0	0	0
Colorado pikeminnow and razorback sucker	0	0	0	0	0	0

Note:
a. Proportion of habitat affected under any of the alternatives is minor to non-existent and considered insignificant and discountable in effects. See individual species analysis in Appendices H and J.

Table 3-96 Proportion of Habitats Available and Affected by each Alternative for each Federally Listed Threatened and Endangered Species on All Lands in the Project Area

Species	Habitats Available (percent)	Habitats Affected by Alternative (percent) 1	2	5	6	7
Bald eagle	9	<1	1	<1	1	<1
Mexican spotted owl	1.6	<1	<1	0	<1	<1
Southwestern willow flycatcher	<1	0	0	0	0	0
Colorado pikeminnow and razorback sucker	0	0	0	0	0	0

The Proposed Action may affect, but is not likely to adversely affect the Mexican spotted owl, and marginally suitable habitat. This determination is based on the results of periodic survey in areas of potentially suitable habitat, and the lack of any detection within the Project Area. There has been no critical habitat identified in the Project Area. The impact to 16 acres of marginally suitable habitat is insignificant and discountable and not expected to degrade the value of the approximate 1,980 acres of habitat in Ignacio Creek/Canyon. Cumulatively, the Proposed Action would not result in adverse impacts to MSO habitat present elsewhere in the SJB, or affect populations that may exist elsewhere in the Basin or in Northern New Mexico.

The Proposed Action may affect, but is not likely to adversely affect the southwestern willow flycatcher or flycatcher habitat. The Proposed Action would not affect suitable habitat, and committed conservation measures are designed to avoid occupied habitat.

Reduced surface flows and altered water quality can degrade the quantity and quality of aquatic habitat both within and downstream of the Project Area. It has been determined that the amount and quality of water delivered to the lower San Juan River determines habitat suitability for the two endangered fishes (USFWS 1995b, SJRB RIP 2003). As a result, it has been the position of the USFWS that any depletion of water from the San Juan Basin, regardless of magnitude, timing,

duration, or source, contributes to the overall cumulative effect of water depletions on the endangered fishes and has the potential to jeopardize the viability of the population. In keeping with previous findings for like actions, we conclude that the Proposed Action may affect, and is likely to adversely affect, the Colorado pikeminnow and razorback sucker.

The Proposed Action may affect, but is not likely to adversely affect Knowlton's cactus based on discountable effects. This determination is based on the fact that there are no known occurrences of this species in the Project Area, because surveys done in the Project Area have not found it, and the fact that if the species is found in the Project Area through pre-construction surveys, no ground-disturbing activities would occur within the buffered area surrounding that population of Knowlton's cactus.

3.9.7.3 Cumulative Effects

3.9.7.3.1 Bald Eagle

Within the 546,600-acre cumulative effects area, there are three bald eagle nests and approximately 27,500 acres of bald eagle winter concentration areas (BLM et al. 2002).

The cumulative effect of the Proposed Action combined with all other existing and proposed oil and gas development would cause a total surface disturbance of 826 acres which is 3 percent of bald eagle winter concentration areas in the cumulative effects analysis area. The Proposed Action would not increase potential impacts to nesting bald eagles because there are no bald eagle nests in the Project Area. Committed conservation measures that prescribe nest avoidance would prevent effects in the event that a bald eagle nest is established in the Project Area. The 243 acres of known winter roosting habitat east of the Project Area would not be impacted by the Proposed Action. Mitigation measures would be implemented to minimize or avoid impacts to any newly discovered winter roost areas as determined by surveys.

Other cumulative effects could result from activities on private lands, such as sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development. Approximately 86 percent of the bald eagle winter concentration areas in the Project Area are located on private lands, primarily along the river valleys where future development could be most intense. Effects on bald eagles from these activities would be in addition to the cumulative effects that have been quantified. Additional background information and details on cumulative effects are presented in the Biological Assessment (BA) (Appendix H).

3.9.7.3.2 Mexican Spotted Owl

Within the 546,600-acre cumulative effects area there are approximately 56,000 acres of mixed conifer and ponderosa pine that may provide foraging habitat for the MSO (BLM et al. 2002). Approximately 1,559 acres, or 2.8 percent, of this area would be impacted by oil and gas development on a cumulative basis.

Other cumulative effects could result from activities on private lands. These effects are not quantifiable but there is little if any suitable MSO habitat on these other land ownerships.

3.9.7.3.3 Southwestern Willow Flycatcher

The Proposed Action would not impact SWWFs or their habitats in the Project Area. Committed conservation measures would prevent disturbance of habitats and restrict project activities from occurring in occupied habitats and during the breeding season. These measures include surveys to be completed within flycatcher habitat located within the development area prior to implementation. This is one of the committed conservation measures required and taken into consideration in determining no impact for the species.

Within the bounds of the SUIT Reservation, the SUIT EIS predicts that a maximum of 5.9 percent of the wooded riparian areas in the SUIT study area would be impacted (BLM et al. 2002). The impact of this disturbance on SWWF habitat is unclear because these areas were not examined to assess their suitability for use by SWWFs. However, committed mitigation measures implemented by the SUIT restrict surface-disturbing activities during the breeding season if any SWWFs are located. These measures would minimize disturbance of SWWF habitat. Therefore, the primary impact to SWWFs from oil and gas development in the cumulative effects analysis area would be any loss of habitat that cannot be avoided on private land within the cumulative effects area. The extent of the impact is not currently quantifiable, but is expected to be a small portion of the available habitats.

Sand and gravel mining, livestock grazing, agriculture, road construction, and rural and urban housing development could also impact SWWF habitat. In the past, these activities have likely caused degradation or loss of substantial amounts of SWWF habitats (Marshall and Stoleson 2000) although no specific data are available for the cumulative effects analysis area. Considering the anticipated growth patterns, these activities are expected to continue into the future and may affect SWWFs because most of their habitats are on private lands, where there is little regulatory control.

3.9.7.3.4 Knowlton's Cactus

Within the cumulative effects area, 5,217 acres of suitable habitat for Knowlton's cactus have been impacted by CBM development, and an additional 3,655 acres of suitable habitat for Knowlton's cactus would be disturbed by oil and gas development within the cumulative effects area (BLM et al. 2002).

Since there are no known prior adverse effects to Knowlton's cactus within the cumulative effects analysis area resulting from past activities, and since there would be no adverse effects to Knowlton's cactus within the cumulative effects analysis area resulting from the Proposed Action or oil and gas development on Tribal lands, there would be minimal adverse cumulative effects to Knowlton's cactus. Impacts could occur on private land if prior surveys are not conducted.

Mitigation measures and pre-construction surveys designed to avoid effects to Knowlton's cactus from all project activities have been and would continue to be

implemented and would minimize the potential for any adverse effects or cumulative adverse effects to this species.

3.9.7.3.5 Colorado Pikeminnow and Razorback Sucker

The analysis area for cumulative effects to the Colorado pikeminnow and razorback sucker includes the Project Area and the San Juan River watershed downstream of the Project Area to Lake Powell.

Approximately 846,000 acre-feet of water per year are annually depleted by a wide variety of current uses. Included in this total are 66 acre-feet per year that would be depleted by new CBM development in the SUIT EIS study area immediately south of the Northern Basin Project Area (BLM et al. 2002).

Although the depletions associated with the alternatives are small relative to total depletions within the basin, they would contribute to the overall cumulative effect of water depletions on both the Colorado pikeminnow and the razorback sucker.

Impacts to water quality caused by increased sediment loads, and the possibility of spills of fuels, lubricants, drilling fluids, or produced water, are not likely to have measurable effects on habitats of the endangered fishes. The probability of contaminating spills is low and best management practices would control sedimentation, which would be localized in impact. Given the distance between the Project Area and the occupied habitats, impacts would be minimal. Although it is reasonable to assume the CBM impacts would be minor, how these impacts might function in combination with the other cumulative effects to water quality, and how they might eventually influence habitats used by the pikeminnow and sucker, is uncertain.

3.9.7.4 Mitigation and Monitoring

Unless otherwise stated, the following measures would be funded by the companies.

3.9.7.4.1 Bald Eagle

- Conduct surveys of nesting and potential roosting areas during appropriate seasons each year before site-specific project activities begin to determine if nest and roosting sites are active. Times and locations for these surveys shall be established in consultation with the Authorized Officer.
- Construct well pads, compressor stations, and ROWs at least ¼ mile from active bald eagle nests and active winter roosts.
- Restrict activities other than routine maintenance that could disturb nesting within ½ mile of an active bald eagle nest between January 1 and July 1
- No activities other than routine well activities (activities that are conducted in the course of maintaining production operations at a well site such as daily site visits, minor repairs on surface equipment or removal of produced water by truck) shall take place within bald eagle winter concentration areas between November 15 and March 15, unless approved by the Authorized Officer. If the Authorized Officer approves routine well activities within bald ea-

gle winter concentration areas between November 15 and March 15, it shall be restricted to a period between 9:00 a.m. and 3:00 p.m.

- Emergency workovers that are necessary and proposed to take place between November 15 and March 15 in bald eagle winter concentration areas, such as pump replacement/repair, plugged tubing, swabbing or associated operations to unload fluids from a well, a hole in the tubing or activities to repair a well bore and/or surface equipment in order to ensure environmental protection would be approved by the Authorized Officer. These activities are limited to daylight hours only and would be of short duration.
- Avoid removal of large cottonwood, ponderosa pine, or other trees within bald eagle winter concentration areas, winter roosts, and areas that may provide nesting habitat.
- Construct aboveground power lines using raptor protection measures (APLIC 1994, 1996) that are designed to reduce the potential for avian collision and electrocution.

3.9.7.4.2 Mexican Spotted Owl

- Implement Mexican spotted owl management guidelines according to the Mexican Spotted Owl Recovery Plan should any breeding or resident owls be discovered in the Project Area (USFWS 1995a).

3.9.7.4.3 Southwestern Willow Flycatcher

- Conduct surveys for the southwestern willow flycatcher during the pre-construction phase. Times and location of surveys shall be established in consultation with the Authorized Officer (breeding surveys would occur between May 15 and July 20, and would be in accordance with the latest USFWS protocol). In the absence of completed and approved surveys, all suitable southwestern willow flycatcher habitats shall be assumed to be occupied.
- Prohibit disturbance to occupied southwestern willow flycatcher habitat by siting facilities a minimum of 100 meters away from such habitat. If birds are located during survey efforts, no surface disturbing activities would be conducted from May 1 to August 15.
- Avoid disturbance to suitable southwestern willow flycatcher habitat by siting facilities a minimum of 100 meters away from such habitat.
- Minimize construction in wooded riparian habitats.
- BMPs for riparian/wetland areas would be implemented to avoid adverse impacts to these habitats.

3.9.7.4.4 Colorado Pikeminnow and Razorback Sucker

- Use BMPs to avoid contamination of local streams and rivers to protect the Colorado pikeminnow and razorback sucker.

3.9.7.4.5 Knowlton's Cactus

- A professional botanist would conduct pre-construction surveys for Knowlton's cactus in all potential areas of disturbance that are identified as suitable habitat (all lands within the pinyon-juniper and sagebrush vegetation types, and all other lands below 8000 feet in elevation) during the pre-

construction phase of the project. Since Knowlton's cactus is extremely inconspicuous except when in flower, pre-construction surveys for Knowlton's cactus would occur between April 1 and May 15 when the species is most likely to be flowering.

➢ Avoid Knowlton's cactus plants and populations and the buffers around them that may be affected by activities.

3.9.7.5 Conformance to Existing Plans and Policies

Management of federally listed threatened and endangered species generally falls under the requirements of the ESA, as administered by the USFWS. Management of these species by other agencies, such as the BLM and FS are based on compliance with the ESA and USFWS directives. The BA (Appendix H) satisfies the requirements of the ESA.

3.9.8 Forest Service and BLM Sensitive Species

3.9.8.1 Affected Environment

A list of 33 FS Region 2 sensitive species with habitat on the SJNF was reviewed for consideration in the Biological Evaluation (BE), also referred to as the BE (FS 2005). Table 3-97 lists sensitive species with habitat on the SJNF and those species evaluated in detail in the BE because of suitable habitat presence on NFS lands, or the species and/or its habitat could be affected by the proposed action.

After reviewing information on occurrence and availability of suitable habitats for the 33 species, 15 of these species are not expected to occur on NFS lands, or be affected by the proposed action due to the absence of suitable habitat. These 15 species include: boreal toad, American bittern, black swift, boreal owl, Columbian sharp-tailed grouse, northern harrier, purple martin, short-eared owl, western burrowing owl, western yellow-billed cuckoo, white-tailed ptarmigan, Colorado River cutthroat trout, American marten, North American wolverine, and river otter.

A complete evaluation is presented for the remaining 18 species, including a discussion on distribution and status, species biology and habitat requirements, limiting factors, and critical time periods in the BE. These 18 species include: northern leopard frog, American peregrine falcon, American three-toed woodpecker, Brewer's sparrow, ferruginous hawk, flammulated owl, Lewis' woodpecker, loggerhead shrike, northern goshawk, olive-sided flycatcher, bluehead sucker, flannelmouth sucker, roundtail chub, Great Basin silverspot, fringed myotis, Gunnison's prairie dog, spotted bat, and Townsend's big-eared bat. Table 3-98 lists existing habitat present on NFS lands for the 18 species. A more detailed description of habitat conditions are presented in the BE (Appendix I).

A list of 20 State of Colorado BLM sensitive species were reviewed for consideration in the BE (BLM 2000e). Table 3-99 lists sensitive species with habitat across the San Juan Resource Area, and those species evaluated in detail in the BE because of suitable habitat presence on BLM lands, or the species and/or its habitat could be affected by the proposed action.

After reviewing information on occurrence and availability of suitable habitats for the 20 species, 8 of these species are not expected to occur on BLM lands, or be affected by the proposed action due to the absence of suitable habitat. These eight species include: black tern, Columbian sharp-tailed grouse, Gunnison sage grouse, western yellow-billed cuckoo, white-faced ibis, Colorado River cutthroat trout, desert spiny lizard, and longnose leopard lizard.

Table 3-97 Forest Service Region 2 Sensitive Species with Habitat on the SJNF

Species	Habitat Associations	Habitat Present In Project Area	Species Evaluated in Detail
Amphibians			
Boreal toad (*Bufo boreas boreas*)	Damp conditions in the vicinity of marshes, wet meadows, streams, beaver ponds, glacial kettle ponds, and lakes interspersed in subalpine forest (lodgepole pine, Engelmann spruce, subalpine fir, and aspen). Sometimes found where ponderosa pine is present. Elevational range is mainly 8,500 ft. to 11,500 ft. with higher and lower occurrences in some areas.	No	No
Northern leopard frog (*Rana pipiens*)	Wet meadows and the banks and shallows of marshes, ponds, glacial kettle ponds, beaver ponds, lakes, reservoirs, streams, and irrigation ditches. Generally found at the waters edge. Elevation range extends up to 11,000 ft in southern Colorado.	Yes	Yes
Birds			
American bittern (*Botaurus lentiginosus*)	Cattail marshes and sometimes in adjacent wet meadows. Rarely seen outside of marshes around lakes and in riparian areas, primarily in spring and fall migration.	No	No
American peregrine falcon (*Falco peregrinus anatum*)	Breeding pairs nest on cliffs and forage over adjacent coniferous and riparian forests, and at times other habitats. Migrants and winter residents occur mostly around reservoirs, rivers, and marshes, grasslands, and agricultural areas.	Yes	Yes
American three-toed woodpecker (*Picoides dorsalis*)	Primarily spruce-fir forests, but where insect populations are high it may also occur in ponderosa pine, Douglas-fir, and lodgepole pine forests.	Yes	Yes
Black swift (*Cypseloides niger*)	Nest on precipitous cliffs near or behind high waterfalls. Foraging birds range at high elevations widely over most montane and adjacent lowland habitats.	No	No
Boreal owl (*Aegolius funereus*)	Mature spruce-fir or spruce-fir/lodgepole pine with meadows.	No	No
Brewer's sparrow (*Spizella breweri*)	Breeds primarily in sagebrush shrublands, but also other shrublands such as mountain mahogany or rabbitbrush.	Yes	Yes
Burrowing owl (*Athene cunicularia*)	Grasslands; usually in or near prairie dog towns.	No	No
Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*)	Gambel oak and serviceberry shrublands, often interspersed with sagebrush shrublands, aspen forests, wheatfields, and irrigated meadows and alfalfa fields. The Colorado Division of Wildlife (CDOW) has recently reintroduced the species onto private lands adjacent to the Dolores Ranger District/Field Office.	No	No
Ferruginous hawk (*Buteo regalis*)	Grasslands and semidesert shrublands, and rare in pinyon-juniper woodlands.	Yes	Yes

Table 3-97 Forest Service Region 2 Sensitive Species with Habitat on the SJNF

Species	Habitat Associations	Habitat Present In Project Area	Species Evaluated in Detail
Flammulated owl (*Otus flammeolus*)	Old growth or mature ponderosa pine and ponderosa-Douglas-fir forests, often mixed with mature aspen; pure aspen; and old growth pinyon-juniper woodlands.	Yes	Yes
Lewis' woodpecker (*Melanerpes lewis*)	Lowland and foothill riparian forests, agricultural areas, edges of ponderosa pine stands and urban areas with tall deciduous trees; rarely in pinyon-juniper woodlands.	Yes	Yes
Loggerhead shrike (*Lanius ludovicianus*)	Sagebrush and occasionally oakbrush with big well developed openings of grasslands, agricultural areas, semi-desert shrublands, and sometimes open pinyon-juniper woodlands; breeding birds are usually near isolated trees or large shrubs.	Yes	Yes
Northern goshawk (*Accipiter gentilis*)	Mature deciduous, coniferous, and mixed forests year-round.	Yes	Yes
Northern harrier (*Circus cyaneus*)	Grasslands, shrublands, wetlands, agricultural, and alpine tundra in fall.	No	No
Olive-sided flycatcher (*Contopus cooperi*)	Breeds primarily in mature spruce-fir and Douglas-fir forests, especially on steep slopes or near cliffs, and less often in other types of coniferous forests, montane and foothill riparian, and aspen forests; burned areas.	Yes	Yes
Purple martin (*Progne subis*)	Old growth and mature aspen forests near parks and generally near water; mixed aspen/ponderosa pine or aspen/Douglas-fir forests.	No	No
Short-eared owl (*Asio flammeus*)	Open habitats including grasslands, marsh edges, shrub-steppes, and agricultural lands.	No	No
White-tailed ptarmigan (*Lagopus leucurus*)	Alpine tundra. Areas that are mostly snowfree early in the season are used for breeding and females with broods generally occur on rocky, wet tundra. Males generally winter above timberline in areas of short willow thickets, while females often winter at or below timberline in taller, denser willow thickets and along willow-dominated watercourses.	No	No
Yellow-billed cuckoo (*Coccyzus americanus*)	Low elevation willow riparian and cottonwood.	No	No
Fish			
Bluehead sucker (*Catostomus discobolus*)	Rocky riffles and runs of small to large rivers in the Colorado River drainage.	Yes	Yes
Colorado River cutthroat trout (*Onchorynchus clarki pleuriticus*)	Upper reaches of specific streams in the Colorado River drainage including the San Juan National Forest.	No	No
Flannelmouth sucker (*Catostomus latipinnis*)	Rocky pools, runs, and riffles of medium to large rivers; less often in creeks and small rivers, in the Colorado River drainage.	Yes	Yes
Roundtail chub (*Gila robusta*)	Rocky runs, sometimes pools, of creeks and small to large rivers; sometimes common in impoundments.	Yes	Yes
Insects			
Great Basin silverspot (*Speyeria nokomis nokomis*)	Moist meadows, seeps, marshes, and streamsides primarily below 7,500 ft.	Yes	Yes
Mammals			
American marten (*Martes americana*)	Spruce-fir and mesic coniferous forests with complex physical structure on the ground.	No	No

Table 3-97 Forest Service Region 2 Sensitive Species with Habitat on the SJNF

Species	Habitat Associations	Habitat Present In Project Area	Species Evaluated in Detail
Fringed myotis (*Myotis thysanodes*)	Pinyon-juniper and ponderosa pine woodlands; caves, mines, and buildings form suitable roost sites; known elevation is up to 7,500 ft.	Yes	Yes
Gunnison's prairie dog (*Cynomys gunnisoni*)	Grasslands, semidesert and montane shrublands	Yes	Yes
River otter (*Lontra canadensis*)	Specific drainages with fish across the San Juan NF including the San Juan River, Animas River, Piedra River, Los Pinos River, Florida River, and Dolores River.	No	No
Spotted bat (*Euderma maculatum*)	Ponderosa pine, pinyon-juniper woodlands, and open semidesert shrublands; rocky cliffs are necessary to provide suitable cracks and crevices for roosting, as is access to water; found from below sea level in California to 10,600 ft. in New Mexico.	Yes	Yes
Townsend's big-eared bat (*Corynorhinus townsendii*)	Semidesert shrublands, pinyon-juniper woodlands, and open montane forests up to 9,500 ft. elevation; associated with caves and abandoned mines for day roosts and hibernacula but also uses abandoned buildings and crevices on rock cliffs for refuge.	Yes	Yes
Wolverine (*Gulo gulo*)	Alpine, spruce-fir; remote areas with limited disturbance	No	No

Source: FS 2005

Table 3-98 Existing Habitat for Forest Service Sensitive Species on NFS Lands in the Project Area.

	Existing Habitat		
Species	Areal Extent (acres)	Portion of NFS Lands in Project Area (percent)	Portion of Project Area (percent)
Northern leopard frog			
American peregrine falcon	3,224	6.5	2.5
American three-toed woodpecker	1,357	2.7	1.0
Brewer's sparrow	5,265	10.6	4.2
Ferruginous hawk	4,288	8.6	3.4
Flammulated owl	22,325	45.2	17.8
Lewis' woodpecker	28,125	56.9	22.4
Loggerhead shrike	5,265	10.6	4.2
Northern goshawk	11,447	23.1	9.1
Olive-sided flycatcher	11,102	22.4	8.8
Fringed myotis	32,657	66.1	26.0
Gunnison's prairie dog	937	1.8	0.7
Spotted bat	35,045	70.9	27.9
Townsend's big-eared bat	32,657	66.1	26.0

Table 3-99 Colorado Bureau of Land Management Sensitive Fish and Wildlife Species list for the San Juan Resource Area

Species	Habitat Association	Habitat Present in Project Area	Species Evaluated in Detail
Birds			
American peregrine falcon (*Falco peregrinus*)	Breeding pairs nest on cliffs and forage over adjacent coniferous and riparian forests, and at times other habitats; migrants and winter residents occur mostly around reservoirs, rivers, and marshes, grasslands, and agricultural areas.	Yes	Yes
Black tern (*Chlidonias niger*)	Reservoirs and lakes; breeding birds nest in cattail marshes adjacent to open water.	No	No
Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*)	Gambel oak and serviceberry shrublands, often interspersed with sagebrush shrublands, aspen forests, wheatfields, and irrigated meadows and alfalfa fields. The Colorado Division of Wildlife (CDOW) has recently reintroduced the species onto private lands adjacent to the Dolores Ranger District/Field Office.	No	No
Ferruginous hawk (*Buteo regalis*)	Grasslands and semidesert shrublands, and rare in pinyon-juniper woodlands.	Yes	Yes
Gunnison sage grouse (*Centrocercus minimus*)	Sagebrush	No	No
Northern goshawk (*Accipiter gentiles*)	Mature deciduous, coniferous, and mixed forests year-round.	Yes	Yes
Western yellow-billed cuckoo (*Coccyzus americanus*)	Low elevation willow riparian and cottonwood.	No	No
White-faced ibis (*Plegadis chihi*)	Wet meadows, marsh edges, and reservoir shorelines.	No	No
Fish (4)			
Bluehead sucker (*Catostomus discobolus*)	Rocky riffles and runs of small to large rivers in the Upper Colorado and San Juan River drainages.	Yes	Yes
Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*)	Headwaters of specific streams in the Colorado River drainage.	No	No
Flannelmouth sucker (*Catostomus latipinnis*)	Rocky pools, runs, and riffles of medium to large rivers; less often in creeks and small rivers, in the Upper Colorado and San Juan River drainages.	Yes	Yes
Roundtail chub (*Gila robusta*)	Rocky runs, sometimes pools, of creeks and small to large rivers; sometimes common in impoundments in the Upper Colorado and San Juan River drainages.	Yes	Yes
Mammals			
Allen's big-eared bat (*Idionycteris phyllotis*)	In southwestern U.S. habitat includes ponderosa pine, pinyon-juniper woodlands, narrowleaf cottonwood, oakbrush; day roosts in rock crevices, caves, and mines, and therefore associated with cliffs, outcrops, or boulder piles; known elevation from 3,500 ft. to 9,800 ft.	Yes	Yes
Big free-tailed bat (*Nyctinomops macrostis*)	Rocky landscapes, roosting high on cliffs; also roosts in buildings and occasional tree cavities; individual wanderers may be expected over most of Colorado, but probably no breeding population exists within Colorado.	Yes	Yes

Table 3-99 Colorado Bureau of Land Management Sensitive Fish and Wildlife Species list for the San Juan Resource Area

Species	Habitat Association	Habitat Present in Project Area	Species Evaluated in Detail
Fringed myotis (*Myotis thysanodes*)	Pinon-juniper and ponderosa pine woodlands; caves, mines, and buildings form suitable roost sites; known elevation is up to 7,500 ft.	Yes	Yes
Spotted bat (*Euderma maculatum*)	Ponderosa pine, pinyon-juniper woodlands, and open semidesert shrublands; rocky cliffs are necessary to provide suitable cracks and crevices for roosting, as is access to water; found from below sea level in California to 10,600 ft. in New Mexico.	Yes	Yes
Townsend's big-eared bat (*Corynorhinus townsendi*)	Semidesert shrublands, pinyon-juniper woodlands, and open montane forests up to 9,500 ft. elevation; associated with caves and abandoned mines for day roosts and hibernacula but also uses abandoned buildings and crevices on rock cliffs for refuge.	Yes	Yes
Yuma myotis (*Myotis yumanensis*)	Open water is a necessity; riparian woodlands, semidesert shrub, and pinyon-juniper woodlands; associated with semiarid canyonlands and mesas in lower elevations in southwestern Colorado; roosts in crevices in cliffs.	Yes	Yes
Reptiles			
Desert spiny lizard (*Sceloporus magister*)	Shrub-covered dirt banks and sparsely vegetated rocky areas near flowing streams or arroyos. Prefer soft soils beneath greasewood, rabbitbrush, salt-cedar, and other shrubs and also frequently perch on large rocks or in large shrubs or trees. Occurs below 5,100 ft. elevation.	No	No
Longnose leopard lizard (*Gambelia wislizenii*)	Locally near the Dolores River, they inhabit areas with sandy rocky soils and scattered sagebrush, junipers, and skunk brush in canyon bottoms. Occurs below 5,200 ft. elevation.	No	No

Source: (BLM 2000e)

A complete evaluation is presented for the remaining 12 BLM sensitive species, including a discussion on distribution and status, species biology and habitat requirements, limiting factors, and critical time periods in the BE. These 12 species include: American peregrine falcon, ferruginous hawk, northern goshawk, bluehead sucker, flannelmouth sucker, roundtail chub, Allen's big-eared bat, big free-tailed bat, fringed myotis, spotted bat, Townsend's big-eared bat, and Yuma myotis. Table 3-100 lists existing habitat present on BLM lands for the 12 species. A more detailed description of habitat conditions are presented in the BE. For this analysis, BLM lands include lands that contain BLM surface/federal minerals and private surface/federal minerals. The BLM has management jurisdiction over federal minerals occurring below private land surfaces.

3.9.8.2 Forest Service and BLM Sensitive Fish and Wildlife Species — Environmental Consequences

The BE for sensitive fish and wildlife species (Appendix I) analyzed direct, indirect, and cumulative effects from the proposed action and its alternatives on a

total of 30 sensitive species. The direct and indirect effects focused on potential impacts to species on FS and BLM administered lands, addressing species designated by each agency for their respective lands. Cumulative effects were considered across all lands in the Project Area and the Colorado portion of the SJB located south of the Project Area.

Table 3-100 Existing Habitat for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals) and Effects from Existing Oil and Gas Activities

Species	Areal Extent (acres)	Existing Habitat Portion of BLM Lands in Project Area (percent)	Portion of Project Area (percent)
American peregrine falcon	2,358	15	2
Ferruginous hawk	1,354	8	1
Northern goshawk	2,776	18	2.
Allen's big-eared bat	14,245	93	11
Big free-tailed bat	14,388	94	11
Fringed myotis	14,388	94	11
Spotted bat	14,969	98	11
Townsend's big-eared bat	14,388	94.	11
Yuma myotis	10,083	66.	8

Direct, indirect, and cumulative effects were primarily associated with impacts to habitat, impacts from noise and human presence and associated disturbances, and impacts from potential injury or mortality. The effects analysis showed that in most cases, the direct loss of habitat from the proposed action and its alternatives was minor, resulting in low to moderate impacts to the species. However, the actual impact to species is likely to be greater due to reduced habitat effectiveness associated with loss of habitat and increased human presence and disturbance in the area. Consequently, impacts to species may actually be greater and at level where individuals would be adversely affected despite numerous mitigation measures designed to reduce these impacts. For all species, the analysis determined that the magnitude of impact would occur at the project level, and would not affect populations or the viability of the species at the Forest level, or across the San Juan Resource Area.

For the 18 FS sensitive species with habitat present on NFS lands in the Project Area, a determination of "may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide" was made based on the direct, indirect, and cumulative effects analysis completed in the BE (Table 3-101).

For the 12 BLM sensitive species with habitat present on BLM administered lands in the Project Area, a determination of "may adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide" was made based on the direct, indirect, and cumulative effects analysis completed in the BE (Table 3-101).

Table 3-101 FS and BLM Sensitive Species Evaluated and Summary of Effects

Species	Sensitive Status	Evaluated in Detail	Alternative 1	2	5	6	7
Amphibians							
Boreal toad (*Bufo boreas boreas*)	FS	No	NI[1]	NI	NI	NI	NI
Northern leopard frog (*Rana pipiens*)	FS	Yes	MAI[1]	MAI	MAI	MAI	MAI
Birds							
American bittern (*Botaurus lentiginosus*)	FS	No	NI	NI	NI	NI	NI
American peregrine falcon (*Falco peregrinus anatum*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
American three-toed woodpecker (*Picoides dorsalis*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Black swift (*Cypseloides niger*)	FS	No	NI	NI	NI	NI	NI
Black tern (*Chlidonias niger*)	BLM	No	NI	NI	NI	NI	NI
Brewer's sparrow (*Spizella breweri*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Boreal owl (*Aegolius funereus*)	FS	No	NI	NI	NI	NI	NI
Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*)	FS & BLM	No	NI	NI	NI	NI	NI
Ferruginous hawk (*Buteo regalis*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Flammulated owl (*Otus flammeolus*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Gunnison sage grouse (*Centrocercus minimus*)	BLM	No	NI	NI	NI	NI	NI
Lewis' woodpecker (*Melanerpes lewis*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Loggerhead shrike (*Lanius ludovicianus*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Northern goshawk (*Accipiter gentilis*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Northern harrier (*Circus cyaneus*)	FS	No	NI	NI	NI	NI	NI
Olive-sided flycatcher (*Contopus cooperi*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Purple martin (*Progne subis*)	FS	No	NI	NI	NI	NI	NI
Short-eared owl (*Asio flammeus*)	FS	No	NI	NI	NI	NI	NI
Western burrowing owl (*Athene cunicularia*)	FS	No	NI	NI	NI	NI	NI
Western yellow-billed cuckoo (*Coccyzus americanus*)	FS & BLM	No	NI	NI	NI	NI	NI
White-faced ibis (*Plegadis chihi*)	BLM	No	NI	NI	NI	NI	NI
White-tailed ptarmigan (*Lagopus leucurus*)	FS	No	NI	NI	NI	NI	NI
Fish							
Bluehead sucker (*Catostomus discobolus*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Colorado river cutthroat trout (*Onchorynchus clarki pleuriticus*)	FS & BLM	No	NI	NI	NI	NI	NI
Flannelmouth sucker (*Catostomus latipinnis*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Roundtail chub (*Gila robusta*)	FS & BLM	no	NI	NI	NI	NI	NI
Insects							
Great Basin silverspot or Nokomis fritillary (*Speyeria nokomis nokomis*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
Mammals							
Allen's big-eared bat (*Idionycteris phyllotis*)	BLM	Yes	MAI	MAI	MAI	MAI	MAI
American marten (*Martes americana*)	FS	No	NI	NI	NI	NI	NI
Big free-tailed bat (*Nyctinomops macrostis*)	BLM	Yes	MAI	MAI	MAI	MAI	MAI
Fringed myotis (*Myotis thysanodes*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Gunnison's prairie dog (*Cynomys gunnisoni*)	FS	Yes	MAI	MAI	MAI	MAI	MAI
North American wolverine (*Gulo gulo*)	FS	No	NI	NI	NI	NI	NI
River otter (*Lontra canadensis*)	FS	No	MAI	MAI	MAI	MAI	MAI
Spotted bat (*Euderma maculatum*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Townsend's big-eared bat (*Corynorhinus townsendii*)	FS & BLM	Yes	MAI	MAI	MAI	MAI	MAI
Yuma myotis (*Myotis yumanensis*)	BLM	Yes	MAI	MAI	MAI	MAI	MAI
Reptiles							
Desert spiny lizard (*Sceloporus magister*)	BLM	No	NI	NI	NI	NI	NI
Longnose leopard lizard (*Gambelia wislizenii*)	BLM	No	NI	NI	NI	NI	NI

Note:
1. NI – "No Impact"; MAI – "May adversely impact individuals, but not likely to result in a loss of viability on the planning area, nor cause a trend to federal listing or a loss of species viability range wide."

Suitable habitat affected by the proposed action and its alternatives for FS sensitive species is presented on Table 3-102.

Suitable habitat affected by the proposed action and its alternatives for BLM sensitive species is presented on Table 3-103.

Table 3-102 Suitable habitat affected for Forest Service sensitive species on NFS lands in the Project Area

Species	Areal Extent of Habitat (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
Northern leopard frog		*[1]	*	*	*	*	*	*	*	*	*
American peregrine falcon	3,224	52	91	7	36	51	1.61	3.11	0.22	1.12	1.58
American three-toed woodpecker	1,357	20	21	0	5	17	1.47	1.54	0	0.36	1.25
Brewer's sparrow	5,265	62	102	5	44	54	1.18	1.93	0.09	0.84	1.03
Ferruginous hawk	4,288	76	100	11	53	75	1.77	2.33	0.25	1.23	1.74
Flammulated owl	22,325	380	536	76	171	264	1.70	2.50	0.34	0.77	1.18
Lewis' woodpecker	28,125	417	690	74	169	257	1.48	2.45	0.26	0.60	0.91
Loggerhead shrike	5,265	62	102	5	44	54	1.18	1.93	0.09	.084	1.03
Northern goshawk	11,447	225	250	40	108	158	1.97	1.15	0.35	0.94	1.38
Olive-sided flycatcher	11,102	163	299	38	68	116	1.47	2.80	0.34	0.61	1.04
Fringed myotis	32,657	410	774	57	174	277	1.25	2.37	0.17	0.53	0.84
Gunnison's prairie dog	937	13	13	13	13	13	1.38	1.38	1.38	1.38	1.38
Spotted bat	35,045	448	834	54	201	316	1.27	2.37	0.15	.57	0.90
Townsend's big-eared bat	32,657	410	774	57	174	277	1.25	2.37	0.17	0.53	0.84

1. Northern leopard frog habitat described qualitatively in Appendix I – Biological Evaluation

Table 3-103 Suitable Habitat Affected for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals)

Species	Areal Extent of Habitat (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
American peregrine falcon	2,358	11	15	0	10	11	0.46	0.63	0	0.42	0.46
Ferruginous hawk	1,354	7	15	3	7	7	0.51	1.10	0.22	0.51	0.51
Northern goshawk	2,776	8	16	0	7	8	0.28	0.57	0	0.25	0.28
Allen's big-eared bat	14,245	63	120	0	60	63	0.44	0.84	0	0.42	0.44
Big free-tailed bat	14,388	62	120	23	57	62	0.43	0.83	0.15	0.39	0.43
Fringed myotis	14,388	62	120	23	57	62	0.43	0.83	0.15	0.39	0.43
Spotted bat	14,969	63	129	23	59	63	0.42	0.86	0.15	0.39	0.42
Townsend's big-eared bat	14,388	62	120	23	57	62	0.43	0.83	0.15	0.39	0.43
Yuma myotis	10,083	46	94	0	44	46	0.45	0.93	0	0.43	0.45

3.9.8.3 Cumulative Effects

There have been a variety of activities affecting habitat for sensitive wildlife species on public lands, and across the Project Area and Cumulative Effects Analysis Area (CEAA). For this discussion, the cumulative effects from these activities are discussed at three scales, public lands, across the Project Area, and that portion of the SUIT Reservation that has seen and would continue to experience CBM development over the next decade. The CEAA is approximately 546,600 acres, encompassing the Colorado portion of the SJB.

Cumulative impacts for sensitive species are the result of past oil and gas development activities, and other activities primarily timber harvest, fire suppression, livestock grazing, and recreational use on federal lands, and development, ranching, recreation, timber harvest (minor) and agricultural activities on private and state lands. Cumulative habitat affected for FS sensitive species from past oil and gas activities, combined with the proposed action and its alternatives is presented on Table 3-104 and Table 3-105. Cumulative habitat affected for BLM sensitive species from past oil and gas activities, combined with the proposed action and its alternatives is presented on Table 3-106 and Table 3-107. A more detailed cumulative effects analysis is provided in the BE.

The above activities and their effects, when added together, have and would continue to affect wildlife habitat and species in the cumulative effects area. In most cases, the cumulative direct loss of habitat is minor, resulting in low to moderate impacts to the species. However, the actual impact to species is likely to be greater due to reduced habitat effectiveness associated with loss of habitat and increased human presence and disturbance in the area. Short-term cumulative impacts (10 years and less) to species include a minor amount of habitat loss affecting movement patterns, use of suitable habitat, and potential minor decreases in local population densities. Long-term cumulative impacts (greater than 10 years) are the same as short-term, with habitat loss potentially increasing incrementally depending on activities that occur and measures applied to reduce impacts. The greatest impact to species in the long-term would likely be reduced habitat effectiveness associated with human disturbances resulting from population increase and use of the area. Consequently, impacts to species would include continued affects to movement patterns, use of suitable habitat, continued reductions in local population densities, and in the extreme, habitat displacement in localized areas.

3.9.9 State of Colorado Threatened, Endangered, and Special Concern Species

State threatened, endangered, and special concern species are evaluated by the Agencies under different requirements. For both BLM and FS, State-listed species which are also listed under the ESA as Threatened or Endangered are evaluated in the BA. Refer to Section 3.9.7, Federally Listed Threatened and Endangered Species, and the Biological Assessment (Appendix H) for further detail.

Table 3-104 Cumulative Habitat Affected for FS Sensitive Species on NFS Lands in the Project Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects on NFS lands (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
Northern leopard frog		*[1]	*	*	*	*	*	*	*	*	*	*
American peregrine falcon	3,224	37	89	128	44	73	88	2.76	3.97	1.36	2.26	2.72
American three-toed woodpecker	1,357	7	27	28	7	12	24	1.98	2.06	0.51	0.88	1.76
Brewer's sparrow	5,265	48	110	150	53	92	102	2.08	2.84	1.00	1.74	1.93
Ferruginous hawk	4,288	68	144	168	79	121	143	3.35	3.91	1.84	2.82	3.33
Flammulated owl	22,325	202	582	738	278	373	466	2.60	3.30	1.24	1.67	2.08
Lewis' woodpecker	28,125	203	617	893	277	372	460	2.19	3.17	0.98	1.32	1.63
Loggerhead shrike	5,265	48	110	150	53	92	102	2.08	2.84	1.00	1.74	1.93
Northern goshawk	11,447	201	426	451	241	309	359	3.72	3.93	2.10	2.69	3.13
Olive-sided flycatcher	11,102	87	250	386	125	155	203	2.25	3.47	1.12	1.39	1.82
Fringed myotis	32,657	257	667	1,031	314	431	534	2.04	3.15	0.96	1.31	1.63
Gunnison's prairie dog	937	14	18	13	13	13	>1	>1	>1	>1	>1	>1
Spotted bat	35,045	298	746	1,132	352	499	614	2.12	3.23	1.00	1.42	1.75
Townsend's big-eared bat	32,657	257	667	1,031	314	431	534	2.04	3.15	0.96	1.31	1.63

Note:
1. Northern leopard frog habitat described qualitatively in Appendix I – Biological Evaluation

Table 3-105 Cumulative Habitat Affected for FS Sensitive Species in the Cumulative Effects Analysis Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
Northern leopard frog		*[1]	*	*	*	*	*	*	*	*	*	*
American peregrine falcon	31,686	2,507	2,649	2,689	2,525	2,557	2,631	8.36	8.48	7.96	8.06	8.30
American three-toed woodpecker	1,528	7	27	28	7	12	24	1.76	1.83	1.76	0.78	1.57
Brewer's sparrow	174,077	12,509	12,649	12,682	12,601	12,636	12,649	7.26	7.28	7.23	7.25	7.26
Ferruginous hawk	193,371	9,424	9,431	9,439	9,427	9,431	9,431	4.87	4.88	4.87	4.87	4.87
Flammulated owl	63,932	1,310	1,770	1,917	1,411	1,481	1,654	2.76	2.99	2.20	2.31	2.58
Lewis' woodpecker	86,213	1,824	2,369	2,674	1,931	2,004	2,149	2.74	3.10	2.23	2.32	2.49
Loggerhead shrike	174,077	12,509	12,649	12,682	12,601	12,636	12,649	7.26	7.28	7.23	7.25	7.26
Northern goshawk	46,250	1,308	1,591	1,675	1,362	1,410	1523	3.44	3.62	2.94	3.04	3.29
Olive-sided flycatcher	31,410	647	856	923	697	733	792	2.72	2.93	2.21	2.33	2.52
Fringed myotis	427,231	20,755	21,165	21,529	20,812	20,929	21,032	4.95	5.03	4.87	4.89	4.92
Gunnison's prairie dog	937	14	18	13	13	13	>1	>1	>1	>1	>1	>1
Spotted bat	446,560	23,327	23,775	24,161	23,381	23,528	23,643	5.32	5.41	5.23	5.26	5.29
Townsend's big-eared bat	427,231	20,755	21,165	21,529	20,812	20,929	21,032	4.95	5.03	4.87	4.89	4.92

Note:
1. Northern leopard frog habitat described qualitatively in Appendix I – Biological Evaluation
2. National Forest only. Impacts not known on SUIT Reservation or elsewhere in cumulative effects area

Table 3-106 Cumulative Habitat Affected for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals) in the Project Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
American peregrine falcon	2,358	22	33 ·	37	22	32	33	1.39	1.56	0.93	1.35	1.39
Ferruginous hawk	1,354	10	17	25	13	17	17	1.25	1.84	0.96	1.25	1.25
Northern goshawk	2,776	3	11	19	3	10	11	0.39	0.68	0.10	0.36	0.39
Allen's big-eared bat	14,245	69	132	189	69	129	132	0.92	1.32	0.48	0.90	0.92
Big free-tailed bat	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Fringed myotis	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Spotted bat	14,969	76	139	205	99	135	139	0.92	1.36	0.66	0.90	0.92
Townsend's big-eared bat	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Yuma myotis	10,083	59	105	153	59	103	105	1.04	1.51	0.58	1.02	1.04

Note:

Table 3-107 Cumulative Habitat Affected for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals) in the Cumulative Effects Analysis Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
American peregrine falcon	31,686	2,507	2,518	2,522	2,507	2,517	2,518	7.94	7.95	7.91	7.94	7.94
Ferruginous hawk	193,371	9,424	9,431	9,439	9,427	9,431	9,431	4.87	4.88	4.87	4.87	4.87
Northern goshawk	46,250	1,308	1,316	1,324	1,308	1,315	1,316	2.84	2.86	2.82	2.84	2.84
Allen's big-eared bat	442,613	20,139	20,202	20,259	20,139	20,199	20,202	4.56	4.57	4.55	4.56	4.56
Big free-tailed bat	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Fringed myotis	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Spotted bat	462,238	23,599	23,662	23,728	23,622	23,658	23,662	5.11	5.13	5.11	5.11	5.11
Townsend's big-eared bat	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Yuma myotis	378,734	18,766	18,812	18,860	18,766	18,810	18,812	4.96	4.97	4.95	4.96	4.96

Note:

For the FS, the remaining State-listed species were evaluated by the Sensitive Species program in a 2005 revision of the Region 2 Regional Forester's Sensitive Species List (FSM 2670 supplement 2600–2005–1). This process evaluated all State-listed species and State special concern species for appropriateness of inclusion onto the Region 2 Regional Forester's Sensitive Species List. At the project level, those R2 sensitive species known or likely to occur or that have habitat on NFS lands within the project area were evaluated in a biological evaluation. Refer to Section 3.9.8, FS and BLM Sensitive Species, and the Biological Evaluation (Appendix I) for further detail. FS policy does not require further

analysis for a State-listed species or State special concern species that was not addressed in either the BA or BE.

For BLM, all remaining State-listed species known or likely to occur or that have habitat on BLM administered lands within the project area were treated in accordance with BLM 6840 manual direction for special status species and no further analysis is required. Finally, in accordance with the BLM manual, management direction found in the BLM RMP, along with project-level design criteria and species-specific conservation and mitigation measures and leasing stipulations, provide additional species-specific conservation measures for State-listed species.

3.9.10 Migratory Birds

Migratory bird species of conservation concern are discussed in greater detail within Appendix K of this EIS.

3.9.10.1 Land Management Planning For Bird Conservation

The San Juan Public Lands Center recognizes the ecological and economic importance of migratory birds. The FS and BLM implement bird conservation actions on a daily basis through application of LRMP and BLM RMP objectives, standards and guidelines to project-level and planning-level decisions, through application of mitigation and effects analyses for bird species of concern, and by participating in a long-term statewide habitat-based bird monitoring program, Monitoring Colorado's Birds (Beason et al. 2005), and a number of local bird monitoring activities such as the North American Breeding Bird Survey (Sauer et al. 2005).

3.9.10.2 Bird Conservation Lists and Species Considered

This migratory bird analysis focuses on species that have been identified as candidates for conservation actions by at least one of the following seven lists: the USFWS Birds of Conservation Concern list (USFWS 2002) for the Southern Rockies/Colorado Plateau Bird Conservation Region (BCR 16), Partners in Flight Colorado Bird Conservation Plan (Beidleman 2000) for the Southern Rocky Mountains Physiographic Area (PA 62), Colorado Listing of Endangered, Threatened and Wildlife Species of Special Concern (CDOW 2005), the U.S. Forest Service Rocky Mountain Region Sensitive Species List (FS 2005), the BLM Colorado State Director's Sensitive Species List (BLM 2000e), unit species listed under the federal ESA (USFWS 07/14/2005, and species designated as Management Indicator Species on the SJNF (FS 1983 and 1992).

There are 55 species of migratory birds included on at least one of these seven lists, and there is considerable overlap between lists. Table 3-108 displays each bird species and the list(s) on which it is identified. Table 3-108 also describes the general habitat type that each species is most closely associated with on San Juan Public Lands during their primary season of occurrence, and the species likelihood of occurrence in the Project Area. More detailed information about the

habitat requirements, status, distribution, abundance, and key habitat components of most species is on file at the San Juan Public Lands Center office in Durango, Colorado.

3.9.10.3 Scope and Scale of Analysis

The bird conservation lists overlap to varying extents, with each list carrying its own particular set of administrative policies and geographic scale of inference. To simplify the large number of bird species from lists that overlap to varying extents, the geographic scale of analysis selected for direct and indirect effects analysis is Federal lands within the NSJB Project Area. The scale of analysis for cumulative effects encompasses the Colorado portion of the San Juan Basin as described in detail at the beginning of this chapter, ensuring consistency with the cumulative effects analysis area for other wildlife sections.

This migratory bird analysis provides a detailed review of the effects of the alternatives for those bird species identified on one of the bird conservation lists that have a moderate or high probability of occurring on Federal lands (National Forest or BLM) in the Project Area. Species that are likely to occur only on non-Federal lands in the Project Area are not reviewed in detail because this FEIS has no decision-making authority over surface management decisions or bird conservation opportunities on non-Federal lands.

3.9.10.4 Direct and Indirect Effects

Bird species of concern are combined into eight analysis groups based on preferred general habitats (e.g. piñon-juniper species) or key habitat components (e.g. cavity nesters) (Table 3-108). The analysis sections below describe the expected effects from project implementation to each analysis group and the likely impact of implementing each alternative on the conservation of species of concern within each group.

Activities associated with CBM production are expected to be much less impacting to bird species of concern than activities associated with project development. Activities associated with CBM production include vehicle movement (usually pickup-class) typically one trip per day or less per well site for purposes of equipment monitoring and maintenance. Sites with remote telemetry are expected to be visited less often. Production facilities such as compressor stations and injection wells would be visited more often (daily), by larger-class vehicles, and for longer periods of time. Activities associated with project development include movement of drilling and earth-moving equipment, clearing of well pads and corridors for roads and pipelines, noise associated with generators and construction activities and equipment, and night lighting of drill rigs during well drilling operations. These production-associated effects are expected to be relatively high at and immediately surrounding work sites but relatively short in duration and small in scale in relation to the amount of habitat available on Federal lands in the Project Area.

Table 3-108 Migratory Birds from Identified Conservation Lists. All Species are Known or are Thought Likely to Occur on Lands Administered by the SJNF and/or SJFO, but some are not Likely to Occur on Federal Lands in the Project Area

Species	Status[1]	Preferred Habitats	Likelihood of Occurrence	Season of Occurrence	Project Area (PA) Analysis Group
American Bittern	FS	Riparian/Wetlands (cattail marsh)	Low	N/A	N/A, no marshes on Federal lands in PA
American Dipper	PIF	Riparian/Wetlands (fast-moving streams)	Low	N/A	N/A, no habitat on Federal lands in PA
American Pipit	PIF	Agricultural, Alpine Tundra	Low	N/A	N/A, no habitat on Federal lands in PA
American Three-toed Woodpecker	FS	Spruce-Fir, Mixed Conifer	Moderate	Non-breeding Season	Cavity Dependant
Bald Eagle	ESA, State, MIS	Riparian/Wetlands (cottonwood gallery forest), Grassland, Sagebrush, Piñon-Juniper, Ponderosa Pine	High	Non-breeding Season	Riparian/Wetlands
Band-tailed Pigeon	PIF	Ponderosa Pine	High	Breeding Season	Ponderosa Pine
Black Swift	FS, BCR, PIF	Riparian/Wetlands (waterfalls)	Low	N/A	N/A, no waterfalls on Federal lands in PA
Black Tern	BLM	Riparian/Wetlands (cattail marsh)	Low	N/A	N/A, no cattail marshes on Federal lands in PA
Black-throated Gray Warbler	BCR	Piñon-Juniper	High	Breeding Season	Piñon-Juniper
Blue Grouse	PIF	Mixed Conifer	High	Year Round	Mixed Conifer
Boreal Owl	FS, PIF	Spruce-Fir	Low	N/A	N/A, no spruce-fir on Federal lands in PA
Brewer's Sparrow	FS, PIF	Sagebrush	High	Breeding Season	Sagebrush
Broad-tailed Hummingbird	PIF	Mountain Shrub, Aspen, Ponderosa Pine, Mixed Conifer, Riparian/Wetland	High	Breeding Season	Mountain Shrub
Brown-capped Rosy Finch	PIF	Alpine Tundra	Low	N/A	N/A, no alpine tundra on Federal lands in PA
Columbian Sharp-tailed Grouse	FS, BLM, State, MIS	Mountain Shrub	Low	N/A	N/A, not known to occur in La Plata or Archuleta Counties
Cordilleran Flycatcher	PIF	Riparian/Wetlands (canyon streams)	High	Breeding Season	Riparian/Wetlands
Ferruginous Hawk	FS, BLM, BCR, State	Grasslands, Agricultural, Sagebrush	High	Non-breeding Season	Sagebrush
Flammulated Owl	FS, BCR, PIF	Ponderosa Pine	High	Breeding Season	Cavity Dependant
Golden Eagle	BCR	Barren (rock cliffs), Agricultural, Grasslands, Alpine Tundra	High	Year Round	Rock Cliff Nesting
Grace's Warbler	BCR, PIF	Ponderosa Pine	High	Breeding Season	Ponderosa Pine
Gray Vireo	BCR	Piñon-Juniper	High	Breeding Season	Piñon-Juniper
Green-tailed Towhee	PIF, MIS	Mountain Shrub, Sagebrush	High	Breeding Season	Mountain Shrub
Gunnison Sage Grouse	FS, BLM, BCR, ESA, PIF, State	Sagebrush	Low	N/A	N/A, not known to occur in La Plata or Archuleta Counties

Table 3-108 Migratory Birds from Identified Conservation Lists. All Species are Known or are Thought Likely to Occur on Lands Administered by the SJNF and/or SJFO, but some are not Likely to Occur on Federal Lands in the Project Area

Species	Status[1]	Preferred Habitats	Likelihood of Occurrence	Season of Occurrence	Project Area (PA) Analysis Group
Hairy Woodpecker	MIS	Ponderosa Pine, Mixed Conifer, Spruce-Fir, Aspen, Piñon-Juniper, Riparian/Wetlands (cottonwood gallery forest)	High	Year Round	Cavity Dependant
Hammond's Flycatcher	PIF	Mixed Conifer, Spruce-Fir	High	Breeding Season	Mixed Conifer
Lazuli Bunting	PIF	Riparian/Wetlands (riparian shrublands)	High	Breeding Season	Riparian/Wetlands
Lewis' Woodpecker	FS, BCR, PIF	Ponderosa Pine, Riparian/Wetlands (cottonwood gallery forest)	High	Year Round	Cavity Dependant
Loggerhead Shrike	FS	Sagebrush, Piñon-Juniper, Agriculture	Moderate	Non-breeding Season	Sagebrush
MacGillivray's Warbler	PIF	Riparian/Wetlands (riparian shrublands)	High	Breeding Season	Riparian/Wetlands
Mallard	MIS	Riparian/Wetlands (lakes and rivers)	High	Year Round	Riparian/Wetlands
Merriam's Turkey	MIS	Ponderosa Pine, Mixed Conifer, Grasslands, Aspen, Mountain Shrub	High	Year Round	Ponderosa Pine
Mexican Spotted Owl	ESA, PIF, State, MIS	Mixed Conifer in steep rock-walled canyons	Moderate	Non-breeding Season	Mixed Conifer; one confirmed occurrence nearby but none in PA
Mountain Bluebird	MIS	Ponderosa Pine, Mixed Conifer, Spruce-Fir, Aspen, Piñon-Juniper, Sagebrush, Grasslands	High	Breeding Season	Cavity Dependant
Northern Goshawk	FS, BLM, MIS	Ponderosa Pine, Mixed Conifer, Spruce-Fir, Aspen	High	Year Round	Ponderosa Pine
Northern Harrier	FS, BCR	Riparian/Wetlands (cattail marsh), Agricultural	Low	N/A	N/A, no cattail marshes on Federal lands in PA
Olive-sided Flycatcher	FS, PIF	Mixed Conifer, Ponderosa Pine, Spruce-Fir	High	Breeding Season	Mixed Conifer
Peregrine Falcon	FS, BLM, BCR, PIF, State	Barren (rock cliffs)	High	Breeding Season	Rock Cliff Nesting
Pinyon Jay	BCR	Piñon-Juniper	High	Year Round	Piñon-Juniper
Prairie Falcon	BCR	Barren (rock cliffs), Grasslands	High	Year Round	Rock Cliff Nesting
Purple Martin	FS, PIF	Aspen	Low	N/A	N/A, not known to nest in La Plata or Archuleta Counties
Red-naped Sapsucker	PIF	Aspen	High	Breeding Season	Cavity Dependant

Table 3-108 Migratory Birds from Identified Conservation Lists. All Species are Known or are Thought Likely to Occur on Lands Administered by the SJNF and/or SJFO, but some are not Likely to Occur on Federal Lands in the Project Area

Species	Status[1]	Preferred Habitats	Likelihood of Occurrence	Season of Occurrence	Project Area (PA) Analysis Group
Sage Sparrow	BCR, PIF	Sagebrush	Moderate	Breeding Season	Sagebrush
Short-eared Owl	FS, BCR, PIF	Riparian/Wetlands (cattail marsh), Agricultural	Low	N/A	N/A, no cattail marshes on Federal lands in PA
Southwestern Willow Flycatcher	ESA, State, MIS	Riparian/Wetlands (riparian shrublands)	Moderate	Breeding Season	Riparian/Wetlands, no confirmed occurrence on Federal lands in PA
Swainson's Hawk	BCR	Agricultural	Low	N/A	N/A, not known to nest in La Plata or Archuleta Counties
Violet-green Swallow	PIF	Aspen, Ponderosa Pine, Barren (rock cliffs)	High	Breeding Season	Cavity Dependant
Virginia's Warbler	BCR, PIF	Mountain Shrub	High	Breeding Season	Mountain Shrub
Western Burrowing Owl	FS, BCR, State	Grasslands (prairie dog colonies)	Low	N/A	N/A, not known to nest in La Plata or Archuleta Counties
White-tailed Ptarmigan	FS, PIF	Alpine Tundra	Low	N/A	N/A, no alpine tundra on Federal lands in PA
Willet	PIF	Riparian/Wetlands (mudflats)	Low	N/A	N/A, no habitat on Federal lands in PA
Williamson's Sapsucker	BCR, PIF	Ponderosa Pine, Mixed Conifer, Spruce-Fir	High	Breeding Season	Cavity Dependant
Wilson's Phalarope	BCR	Riparian/Wetlands (lakes)	Low	N/A	N/A, no habitat on Federal lands in PA
Wilson's Warbler	PIF	Riparian/Wetlands (riparian shrublands)	Moderate	Non-breeding Season	Riparian/Wetlands
Western Yellow-billed Cuckoo	FS, BLM, BCR, ESA, State	Riparian/Wetlands (cottonwood gallery forest)	Low	N/A	N/A, no cottonwood gallery forest on Federal lands in PA

Note:
1. Status Codes: BCR = On Bird Conservation Region 16 (Southern Rockies/Colorado Plateau) Birds of Conservation Concern List (USFWS 2002). BLM = On Colorado BLM Sensitive Fish and Wildlife Species List (BLM 2000e). Effects to these species were analyzed in the BE, Appendix I. ESA = Listed under the ESA as Threatened, Endangered, Proposed or Candidate for Federal listing and known or likely to occur or have habitat on lands administered by the SJNF or SJFO (USFWS 2005). Effects to these species were analyzed in the BA, Appendix H; FS = On FA Rocky Mountain Region Regional Forester's Sensitive Species List (FS 2005a). Effects to these species were analyzed in the Biological Evaluation, Appendix I. MIS = Management Indicator Species for the SJNF. Effects to these species were analyzed in Appendix J. PIF = On Colorado Partners in Flight Physiographic Area 62 List (Beidleman 2000). State = On CDOW's Listing of Endangered, Threatened and Wildlife Species of Special Concern (CDOW 2005).

3.9.10.4.1 Habitat Loss

Varying amounts of nesting and/or foraging habitat for bird species of concern would be lost to project development under each alternative. The extent of impacts would depend primarily on the number of wells drilled, the length of access roads to those wells, and the juxtaposition of infrastructure facilities to key habitat components or preferred habitat types. Bird species that nest or forage in open or grassland habitats would generally gain habitat with infrastructure development because the Project Area is currently mostly forested, while species that

nest or forage in forested and shrubland habitats would generally loose habitat with infrastructure development. Because not all infrastructure sites (e.g. roads) would provide habitat for species associated with open or grassland habitats, there would be a proportionately small habitat gain for species associated with open habitats and proportionately larger habitat loss for species associated with forested or shrubland habitats. Habitat loss for species associated with forested or shrubland habitats would be long term (decades) due to the normally extended time for regeneration of habitat conditions useful to these species (e.g. mature sagebrush, snags and large-diameter trees). In contrast, the gain in habitat for species associated with open or grassland habitats would be almost immediate with benefits continuing long term (e.g. as long as the infrastructure openings are maintained).

Table 3-109 summarizes estimates for the amount of habitat lost to each alternative for each migratory bird analysis group (from Table 3-108) on Federal lands in the Project Area, and ranks alternatives from least (1) to most (5) impacting. The rankings displayed on Table 3-109 are based on the relative amounts of habitat that may be lost under each alternative to project infrastructure and facilities.

In general, the amount of habitat lost under each alternative is relatively small in comparison to the amount of habitat currently available on Federal lands in the Project Area (less than 1 percent to 2.5 percent), and thus the effects of direct habitat loss to each bird analysis group are expected to be generally small. None of the alternatives is expected to cause population-level effects or result in changes in species distribution within the Project Area for any analysis group or bird species of concern. However, all alternatives would result in some loss of breeding, foraging, or wintering habitat for some species of concern. For this reason, all alternatives are expected to cause some disturbance and/or displacement of varying numbers of individual birds.

The degree of effect to each analysis group, or effect to individual bird species of concern, would depend primarily on which alternative is selected, the span of time (i.e. number of years) taken to complete full project build out, and the seasons during which most construction activities occur. In general, smaller numbers of individual birds would be affected by longer periods for complete full project build out because fewer wells would be constructed in any given year and construction activities are likely to be more widely distributed. Conversely, a shorter span for full project build out would affect more area simultaneously across a larger portion of the Project Area, thereby likely increasing the number of individual birds affected by project development. If most project construction activities occur outside the bird breeding season, effects would be reduced for species that breed in the Project Area (30 species) but effects would be increased for species that use the Project Area primarily during the non-breeding season (15 species).

Table 3-109 Relative Impacts on Bird Species of Concern, by Alternative, on Federal Lands and Lands of Private Surface Ownership with Underlying Federal Mineral Rights in the Project Area

	Alternative				
Analysis Group	1	2	5	6	7
Cavity Dependant Group					
Amount of Habitat Affected (% of Available Habitat)	546 (1.3%)	848 (2.0%)	108 (0.3%)	268 (0.6%)	406 (1.0%)
Ranking of Alternatives[2]	4	5	1	2	3
Mixed Conifer Group					
Amount of Habitat Affected (% of Available Habitat)	70 (1.3%)	93 (1.8%)	8 (0.2%)	22 (0.4%)	57 (1.1%)
Ranking of Alternatives	4	5	1	2	3
Mountain Shrub Group					
Amount of Habitat Affected (% of Available Habitat)	125 (0.9%)	274 (1.9%)	7 (<0.1%)	25 (0.2%)	64 (0.4%)
Ranking of Alternatives	4	5	1	2	3
Piñon-Juniper Group					
Amount of Habitat Affected (% of Available Habitat)	125 (0.9%)	225 (1.7%)	16 (0.1%)	80 (0.6%)	103 (0.8%)
Ranking of Alternatives	4	5	1	2	3
Ponderosa Pine Group					
Amount of Habitat Affected (% of Available Habitat)	336 (1.5%)	507 (2.2%)	83 (0.4%)	167 (0.7%)	236 (1.0%)
Ranking of Alternatives	4	5	1	2	3
Riparian/Wetlands Group					
Amount of Habitat Affected (% of Available Habitat)	4 (0.4%)	7 (0.7%)	3 (0.3%)	4 (0.4%)	4 (0.4%)
Ranking of Alternatives	3	5	1	3	3
Rock Cliff Nesting Group					
Amount of Habitat Affected (% of Available Habitat)	7 (0.7%)	19 (2.1%)	0 (0.0%)	8 (0.8%)	7 (0.7%)
Ranking of Alternatives	2.5	5	1	4	2.5
Sagebrush Group					
Amount of Habitat Affected (% of Available Habitat)	30 (1.5%)	30 (1.5%)	6 (0.3%)	23 (1.2%)	30 (1.5%)
Ranking of Alternatives	4	4	1	2	4

3.9.10.4.2 Habitat Loss by Alternative

For all analysis groups, Alternative 5 is expected to result in the least habitat loss (less than 0.4 percent of available habitat on Federal lands in the Project Area). For all but one analysis group, Alternative 2 is expected to result in the most habitat loss (0.7 percent to 2.2 percent of available habitat). For the sagebrush analysis group, Alternative 1, 2 and 7 are expected to result in equal amounts of habitat loss (1.5 percent of available habitat). For the riparian/wetland group, Alternative 1, 6 and 7 are expected to result in equal amounts of habitat loss (0.3 percent of available habitat). For the rock cliff-nesting group, Alternative 1 and 7 are expected to result in equal amounts of habitat loss (2.5 percent of available habitat).

The ranking of alternatives from least to most impacting was the same for five out of eight analysis groups, with the order being Alternative 5, 6, 7, 1, and 2 respectively. These five analysis groups were the cavity dependant, mixed-conifer, mountain shrub, piñon-juniper, and ponderosa pine analysis groups. For the remaining three analysis groups (riparian/wetlands, rock cliff nesters and sagebrush) Alternatives 5 was least impacting and Alternative 1 and 7 were ranked as equally impacting.

Alternative 5, the least impacting alternative for all analysis groups, would result in a relatively small loss of habitat for all analysis groups (0 percent to 0.4 percent of habitat available on Federal lands in the Project Area). Selection of Alternative 5 would have the greatest impact on the cavity dependant group because most of the habitat loss associated with selecting this Alternative (108 acres) would occur in habitats used by cavity dependant species. Effects to the ponderosa pine analysis group (83 acres) would be almost as large as the cavity dependant group. However, the effect of selecting Alternative 5 would be mitigated for these two groups by the large amount of habitat available on Federal lands in the Project Area, about 42,400 acres and 22,800 acres, respectively.

Alternative 6 over Alternative 5 would shift a greater proportion of the effects of habitat loss from the cavity dependant analysis group to the piñon-juniper and sagebrush groups. Compared to Alternative 5, Alternative 6 would double the amount of habitat loss for all analysis groups, except for the riparian/wetland group. The largest rate of increase in acres of habitat loss associated with selection of Alternative 6 would be for the piñon-juniper analysis group. However, the largest amount of habitat lost in comparison to the amount of habitat available (1.2 percent) on federal lands in the Project Area would be for the sagebrush analysis group.

Alternative 7 would have the greatest effect on the sagebrush and mixed-conifer analysis groups. Compared to Alternative 6, selecting Alternative 7 would result in another ⅔ increase in the amount of habitat lost for five of the eight analysis groups. The sagebrush group would have the largest amount of habitat loss compared to the amount available on Federal lands in the Project Area (1.5 percent). The greatest rate of increase in loss of habitat from selecting Alternative 7 over Alternative 6 would be for the mixed-conifer group (0.4 percent to 1.1 percent of available habitat). Although there would be a relatively small amount of habitat lost from mixed conifer habitats, the relatively small and isolated patch size of most mixed conifer stands makes a small habitat loss more impacting than in other habitats with larger and more continuous patches. A relatively small loss of mixed conifer habitat may render naturally small patches unsuitable for occupancy by some mixed conifer species, potentially reducing the continuity of species distribution across the Project Area.

Alternative 1 would shift the burden of habitat loss to the mountain shrub and ponderosa pine analysis groups. The greatest proportionate increase in habitat loss from Alternative 7 to Alternative 1 would be for the mountain shrub and ponderosa pine analysis groups (0.5 percent increase in loss of habitat available on federal lands for both groups). There would be a relatively small increase in habitat loss over Alternative 7 for five of eight analysis groups. There would be

no increase in loss of available habitat from selecting Alternative 1 over Alternative 7 for the riparian/wetland, rock cliff nesting and sagebrush analysis groups.

Alternative 2 (the most impacting alternative for all analysis groups) would shift the burden of habitat loss back to the ponderosa pine and cavity dependant analysis groups. Alternative 2 would result in the greatest loss of habitat for all analysis groups. The cavity dependant group would lose the greatest amount of habitat (848 acres) but the ponderosa pine group would have the greatest loss in percent of habitat available on federal lands in the Project Area (2.2 percent). The mountain shrub and piñon-juniper groups would have similar rates of habitat loss in comparison to the amount available (1.9 percent and 1.7 percent respectively).

3.9.10.4.3 Habitat Loss by Analysis Group

Cavity dependant bird species of concern are divided into two categories, primary cavity excavators that construct a new nesting cavity each season, and obligate secondary cavity nesters that do not regularly construct their own nesting cavities but depend primarily on cavities constructed in previous seasons by primary excavators.

About 76 percent of Federal lands and non-Federal lands with Federal mineral rights in the Project Area (about 42,450 acres) are forested habitats used by cavity dependant species. The most abundant forested habitat type on Federal lands in the Project Area is ponderosa pine, with smaller amounts of piñon-juniper, mixed-conifer, and aspen habitats.

Aspen is an important wildlife habitat type for the cavity dependant analysis group. There is very little aspen-dominated habitat in the Project Area (about 1,300 acres) of which most (97 percent) is on Federal lands. In addition to stands dominated by aspen trees, many parts of the Project Area have conifer-dominated stands with smaller numbers of aspen trees mixed in the forest overstory. Aspen stands usually provide higher quality habitat than surrounding pure conifer stands for snag and cavity dependant birds because of the typically high number of standing dead trees and abundant nest cavities present in aspen trees.

The mitigation measures protecting standing snags from loss to fuel wood harvesting and facility development (see Section 3.9.6.4), as well as mitigation to protect old growth ponderosa pine (see Section 3.8.5) would protect key habitat components for the cavity dependant analysis group. The most important key habitat components for the cavity dependant group are large-diameter (> 16 inches d.b.h.) standing snags, green snag replacement trees and pre-settlement trees that are used as nesting and foraging substrate.

Mixed conifer habitats are less common on Federal lands in the Project Area (about 5,250 acres) than other forested wildlife habitat types and occur mostly in relatively small and isolated patches on north and east facing slopes. Most mixed conifer habitat in the Project Area occurs on Federal lands. Mixed conifer stands in the Project Area are highly variable in species composition and habitat structure (FS 2003a). Many mixed conifer stands have some aspen trees mixed in with the overstory conifers.

Alternative 7 would result in the loss of about 57 acres or 1.1 percent of mixed conifer habitat on Federal lands. Although this is a relatively small amount of habitat loss, the relatively small and isolated patch size of most mixed conifer stands makes a small habitat loss more impacting to species associated with mixed conifer than other more abundant and continuous habitats. A relatively small loss of habitat could render a small habitat patch unsuitable for occupancy by some species thus reducing the continuity of species distribution across the Project Area.

Because of their habitat associations and foraging strategy, the snag and old growth ponderosa pine mitigation measures (see Sections 3.8.5 and 3.9.6.4) would protect key habitat components for the most at risk species in this category.

Mountain shrub habitat provides valuable food and cover for many birds and mammals, including a number of bird species of concern. In addition to Gambel oak, many other shrubs in this community produce edible fruits in late summer that provide high quality food for many wildlife species (Beidleman 2000). Because of the unique importance of mountain shrublands in the Project Area as late summer wildlife foraging habitat, the small losses of productive mountain shrubland habitat proposed by each alternative may adversely affect wildlife at a larger scale than the small acreage figures on Table 3-109 suggest.

Mountain shrub habitat occurs in fairly large and relatively uniform stands in some parts of the Project Area. A habitat management objective of Colorado Partners in Flight Bird Conservation Plan (Beidleman 2000) is to reintroduce small-scale and relatively controlled fire events back into mountain shrub habitats to promote landscape heterogeneity, increase production of native grasses and forbs, increase shrub productivity, and leave healthy mosaic patterns of various aged stands. CBM production may enhance management options in this habitat type by providing road access to formerly remote parts of the Project Area, thereby providing opportunities for the use of prescribed fire for resource benefit in areas where it was formerly not practical due to lack of access and lack of fire control options.

Mountain shrub habitat is the second most abundant habitat type on Federal lands in the Project Area, with about 61 percent of the habitat in the Project Area occurring on Federal lands.

Forest plan standards and guidelines require maintaining minimum habitat capability levels for green-tailed towhee (see Appendix J) and all three mountain shrub bird species of concern would benefit from these standards. The mitigation measure protecting large-diameter Gambel oak stands (see Appendix J) would also protect habitat for all three bird species of concern.

Piñon-juniper is the third most abundant wildlife habitat on Federal lands in the Project Area (about 13,150 acres) with about 60 percent of habitat in the Project Area occurring on Federal lands. Piñon-juniper woodlands are in a stable to increasing trend on San Juan Public Lands (SJNF MIS Assessment unpublished report). Piñon and juniper trees are encroaching into lower-elevation areas that were once extensively sagebrush and associated grassland cover types. This is

largely due to the exclusion of frequent fire. *Ips* bark beetles and black stain root disease are mostly responsible for significant mortality of piñon pine in the Four Corners region noted over the last few years. In general, piñon-juniper woodlands that were once dominated by large trees with openings composed of younger trees, grasses, forbs, and shrubs are now denser, with a corresponding loss of openings (ibid).

Alternative 7, the agency's preferred alternative, would result in the loss of about 103 acres of piñon-juniper habitat (0.8 percent of habitat on Federal lands in the Project Area). This is a relatively small amount of habitat, but when added to the recent drought and beetle induced mortality of piñon pine which has been extensive in some parts of the Project Area, implementation of any of the project alternatives would have a greater impact on species associated with piñon-juniper woodlands than the figures on Table 3-109 suggest.

Ponderosa pine is the most abundant wildlife habitat on Federal lands in the Project Area (about 22,800 acres) with about half of the habitat in the Project Area occurring on Federal lands. More than 80 percent of ponderosa pine habitat in the Project Area is in low- to mid- canopy closure stands with trees that average greater than 9 inches in diameter (wildlife habitat structural stages 4A and 4B). Forest stands with this structure provide good nesting and hunting habitat for all four bird species of concern in the ponderosa pine analysis group (band-tailed pigeon, Grace's warbler, Merriam's turkey, and northern goshawk).

Alternative 7, the preferred alternative, would result in the loss of about 240 acres (1.0 percent) of ponderosa pine habitat on Federal lands in the Project Area, the most from any habitat type in the Project Area. When compared to the large average home range size and wide ranging nature of northern goshawk ([about 5,400 acres] see Appendix I, Kennedy 2003) and band-tailed pigeon (Dexter 1998c), both species are likely to continue using areas and habitats affected by project development to some degree. The large amount, wide distribution and often large patch size of ponderosa pine habitat on Federal lands in the Project Area in comparison to the relatively small size of most project infrastructure sites also helps mitigate the effects of habitat loss. The snag and old growth ponderosa pine mitigation measures (see Sections 3.8.5 and 3.9.6.4) and raptor nest buffers (see Appendix J) would protect key components of goshawk nesting and hunting habitat. The mitigation measure protecting large-diameter Gambel oak stands (Appendix J) would protect foraging habitat for species such as band-tailed pigeon.

Riparian/wetland habitats are used to some degree by most bird species that use the Project Area and thus even small impacts to this habitat type have the potential to affect many more species of concern than the species list and acreage figures presented above suggest. Small amounts of riparian and wetland habitat would be lost under each alternative despite the intention to avoid these environmentally sensitive areas where possible. There is a total of about 990 acres of riparian/wetland habitat on Federal lands in the Project Area, about 29 percent of the habitat in the Project Area. Between 3 and 7 acres of riparian/wetland habitat would be lost to project development, depending on which alternative is selected, resulting in a loss of between 0.3 percent and 0.7 percent of riparian/wetland habitat on Federal land in the Project Area. Alternative 7, the agency's preferred

alternative, would result in the loss of about 4 acres (0.4 percent) of riparian/wetland habitat on Federal lands in the Project Area. This is an area roughly equal to the average home range size of most neotropical migratory bird species of concern in the riparian/wetland analysis group.

Two of these riparian species of concern are protected under the Endangered Species Act and several features have been incorporated into project design to ensure protection of habitat used by these species (see Section 3.9.7.4). It was determined that CBM development in the Project Area "may affect but is not likely to adversely affect" either species or their habitats (FS 2005).

There are a few small springs and seeps at widely scattered locations on Federal lands in the Project Area. These features, surrounded by an otherwise generally arid landscape, provide important habitat diversity and are important for birds of concern in the riparian analysis group. For example, a spring in Armstrong Canyon and several seeps in Ignacio Canyon provide microhabitats that support riparian/wetland species of concern which would otherwise probably not occur in the nearby area. These seeps and springs are probably utilized to some degree throughout the summer by most bird species breeding in adjacent ponderosa pine and mountain shrubland habitats.

In general, riparian and wetland habitats would be avoided wherever possible during project development. In addition to committed conservation measures protecting Threatened and Endangered species habitat (Appendix H), the mitigation measures protecting riparian and wetland habitats (Section 3.8.5 and Appendix J) are developed to protect habitat for all species of concern associated with riparian and wetland habitats.

Rock cliffs provide nesting substrate for three species of concern, all raptors. All three species prefer to nest on prominent cliffs, have high nest site fidelity from year to year, have large home ranges and regularly forage more than a dozen miles from their nest cliffs during a single day (Craig and Enderson 2004, Appendix I). There are few cliffs on Federal lands in the Project Area that have sufficient stature or prominence to provide high quality falcon nest sites or have sufficient structure on the cliff face to hold the bulky stick nest required by golden eagle (Barrett 1998, Jones 1998, Levad 1998).

All three birds of concern in the cliff rock nesting analysis group frequently forage far from their nesting cliffs and in a variety of different habitats. Large home ranges and utilization of a diversity of foraging habitats provides good flexibility in adapting to changes in habitat structure such as human development. Although this analysis group shows a relatively large increase from 0.0 to 2.1 percent habitat loss to project development, these numbers are misleading because no cliffs of sufficient stature to support nesting by these raptors would be lost to project development under any alternative. The estimate of 7 acres (0.7 percent) of habitat lost under Alternative 7, the preferred alternative, and the acreage figures for other alternatives presented on Table 3-109 likely reflect loss of bare ground of unknown habitat type, not loss of cliff nesting habitat.

Nesting habitat for the cliff nesting analysis group would be protected from project development by existing mitigation measures. A half mile no surface occu-

pancy buffer would be placed around the known peregrine falcon nest cliff and any new nests discovered during project implementation (Craig 2002, Appendix I). For the known peregrine falcon nest, a pre-existing road passes through the outer edge of the half-mile buffer zone and one well pad is proposed under alternative 7 within the buffer zone but the falcon nest is protected from these infrastructures by intervening landscape features. If other active raptor nests are found during project implementation, disturbance buffers would be applied where possible (Appendix I and Appendix J).

Sagebrush habitat is perhaps the habitat that has been most heavily modified from its condition prior to European settlement due to conversion to agriculture, livestock grazing, eradication of sagebrush, changes in fire regimes and invasion by non-native grasses with subsequent declines in bird populations (Rich et al. 2004). In the Interior Columbia River Basin, sagebrush was identified as the highest priority habitat for conservation based on bird population trends (ibid). There are about 2,000 acres of sagebrush on Federal lands in the Project Area most of which is in relatively small isolated patches, and about 38 percent of sagebrush habitat in the Project Area is on Federal lands.

The effects of Alternatives 1, 2, 6, and 7 would be very similar on sagebrush species of concern. Alternatives 1, 2, and 7 would result in the loss of 30 acres (1.5 percent) of habitat on Federal lands in the Project Area, while Alternative 6 would result in the loss of 23 acres (1.2 percent) of habitat.

The effect of habitat loss on sagebrush species of concern is likely to be greater than the acreage figures on Table 3-109 suggest, and greater than for most other bird analysis groups. Because there is little sagebrush habitat on public lands and range-wide populations of all species of concern in this analysis group are declining, the loss of small amounts of habitat would have a proportionately larger impact to sagebrush species of concern than for other analysis groups. The relatively small patch size of current sagebrush habitat on Federal lands in the Project Area and relatively isolated nature of many habitat patches make birds in this analysis group more vulnerable to local declines or extirpation.

3.9.10.4.4 Noise and Disturbance

Noise and human disturbance from project development and production activities would reduce habitat effectiveness for bird species of concern to some unknown degree in both the short and long term but the extent, intensity and mechanism of this effect is almost entirely unknown (Van Der Zande et al. 1980). Most noisy disturbances are mild enough that detecting a population response to noise is very difficult against the background of normal annual population variation (Bowles 1995). High levels of human disturbance have been shown to affect the abundance and nest success of birds breeding in grassland and forest habitats (Miller et al. 1998). Busy roads have also been shown to affect bird abundance, productivity, and species composition in wetland, forest, and grassland habitats (Foppen and Reijnen 1994, Reijnen et al 1995, Reijnen et al 1996). Elevated levels of background noise associated with human development have also been shown to adversely affect breeding bird communities (Stone 2000).

Noise levels associated with project activities could increase significantly above existing background levels. Noise associated with development, including drill-

ing and infrastructure construction, would be short-term, intense and closely associated with individual construction sites. Noise associated with production (maintenance traffic, compressor stations, pump jacks, etc.) would be long-term but measurably less and more widespread than noise from construction activities. Noise generated by pump jacks would decrease to 50 dBA at 350 feet, and noise from with building-enclosed compressors would decrease to 50 dBA at 450 feet from the building (Table 3-146). These levels are within the COGCC night-noise standard (50 dBA) at residential areas (Section 3.14.2).

Very few studies have been conducted specifically on the effect of CBM development and production noise on birds of conservation concern. A study was conducted during summer 2005 in nearby San Juan County, New Mexico on the effects of gas well compressor noise on birds nesting in piñon-juniper habitat similar to that in the NSJB Project Area (Ortega and Francis 2005). The preliminary results are from an unpublished report of the study based on only one year of data. The report has not been peer reviewed and the results may change after the study is repeated in subsequent field seasons.

The study found that compressor noise did not affect abundance of nesting birds, but species composition was somewhat altered. There was no significant difference in nest density, nest success or nest predation between experimental and control plots. Compressors did not affect nest orientation.

The study found a "strong trend" for birds to nest further from compressors, when house finch was removed from the analysis. House finch was commonly found nesting in the compressor equipment. This finding implies that the loss of useable habitat due to noise, for some species, could be much greater than the loss of suitable habitat due to infrastructure development.

The study found noise levels exceeded BLM standards (48.6 dBA at 300 feet from source) at 25 percent of nests in treatment plots. The study recommended that noise from gas well compressors, "while not a problem for all species, may present impediments for others" and thus noise should be mitigated to the extent possible until further studies can determine the effect of noise on breeding bird communities.

Noise-Related Displacement and/or Home Range Shift

Some habituation to elevated levels of background noise would occur for some bird species and some individuals, moderating the loss of habitat effectiveness as they adjust to new noise sources. The degree to which habituation would occur and which species would more readily adapt to increased background noise levels and sources is unknown (Bowles 1995). More noise may cause nearby individuals to shift their home range temporarily or permanently away from areas with noise levels above their tolerance. Home range shifts may be temporary in response to short-term construction activities, or home range shifts may be permanent in response to elevated background noise levels associated with long-term production activities.

For bird analysis groups and species associated with ponderosa pine, mountain shrub, piñon-juniper and grassland habitats, there is abundant habitat in similar condition within and immediately adjacent to the Project Area providing oppor-

tunities for displaced individuals to relocate during project development. For bird analysis groups and species associated with sagebrush, riparian/wetlands, aspen and mixed conifer habitats, there is a limited amount of habitat in and immediately adjacent to the Project Area and thus few opportunities for displaced individuals to relocated during project development.

3.9.10.4.5 Recreation-related Disturbance:

High levels of human recreation activity have been shown to affect the abundance and nest success of birds breeding in grassland and forest habitats (Miller et al. 1998). CBM development provides increased motorized and foot access via road networks developed to access well pads and pipeline corridors. New roads proposed under each alternative would provide access to areas that were formally too remote to receive regular recreation beyond occasional disbursed use. Therefore, the new road networks necessary to promote CBM development may reduce bird habitat effectiveness through the effects of disturbance, nest predation and habitat loss or alteration associated with increased recreational use of formerly remote areas.

To reduce these impacts and impacts to other wildlife, all alternatives would prohibit off-road motorized travel and limit motorized uses to designated roads and trails only (Section 3.9.3 and 3.11.5). Only authorized vehicles (mainly industry, agency, and law enforcement) would use new roads developed for the purpose of CBM production. These new roads however, would be open to horse, foot and bicycle travel. Most new roads would be plowed in winter to allow access for maintenance purposes thereby providing opportunities for snowmobile and Nordic ski access into areas that formerly received little or no use. Low elevations and low average winter snows throughout the majority of the Project Area however, would minimize snowmobile use in most years and in most locations. Therefore the effect to habitat for birds of conservation concern would be an increase in habitat effectiveness from the prohibition of off-road motorized travel offset by an increase in non-motorized access to formerly remote areas via roads developed for CBM access.

Recreation use on most new CBM roads is expected to be light to moderate in most parts of the Project Area due to distance from motorized access points but likely to increase slowly over time as human populations and demand for recreational opportunities continue to grow in nearby communities. Horseback and bicycle use are likely to be the most common means of accessing more remote portions of the new road systems.

3.9.10.4.6 Cowbird Parasitism and Predation

Cowbird parasitism and predation are the primary sources of nesting mortality for open-cup nesting birds (Ortega 1998, Ortega and Francis 2005). Brown-headed cowbirds are native to the Four Corners region and to the Project Area (Ortega pers. comm.) thus migratory birds nesting in the Project Area have evolved in the presence of brood parasitism. Cowbirds have been declining across the Breeding Bird Survey region since 1966 (Chace et al. 2005). Cowbird distribution and abundance is determined primarily by spatial distribution of preferred foraging habitat (open habitats) and breeding habitat (habitats with more complex structure) and they establish spatially separate foraging and breeding

home ranges (Chace et al. 2005). In landscapes where feeding and breeding habitats are spatially separated, cowbirds commute daily between the two for an average of 0.6 to 1.8 miles (ibid).

Ortega (1998) listed 226 bird species known to have been victims of brown-headed cowbird parasitism. Fifteen birds of conservation concern that may occur in the Project Area (42 percent, Table 3-108) are documented to have been parasitized. Not all migratory songbirds are likely to be victims of cowbird parasitism (i.e. cavity nesters), and not all victims of cowbird parasitism are adversely affected. Some host species eject cowbird eggs while other hosts build new nests over top of parasitized nests (Robinson et al. 1995, Ortega 1998). Cowbirds are attracted to habitat edges and livestock feeding sites (Robinson et al. 1995, Ortega 1998) and thus project infrastructure development may increase habitats favorable to cowbirds, thereby potentially increasing cowbird parasitism rates in the Project Area.

In a single-year study however, in an area of CBM development similar to and near the Project Area, Ortega and Francis (2005) found a relatively low overall rate of cowbird parasitism compared to other areas of southwest Colorado (Ortega and Ortega 2001, Ortega and Ortega 2003). Ortega and Francis (2005) also found no correlation between CBM compressor noise and cowbird parasitism or songbird nest predation rates. Miller et al. (1998) found no relationship between cowbird abundance or parasitism and distance from forest trails in a heavily used recreation area of eastern Colorado.

Grazing by domestic livestock in the Project Area is brief, relatively light and closely managed each year. Livestock grazing seasons, movements and stocking rates would not be affected by CBM development alternatives and thus CBM development is unlikely to affect cowbird distribution or abundance in the Project Area through changes in livestock grazing patterns.

Numerous studies have linked habitat fragmentation with increased cowbird parasitism rates and increased rates of predation of open-cup nesting birds (Robinson et al. 1995). However, these studies have been conducted primarily in eastern and mid-western landscapes that are comprised primarily of large contiguous tracks of densely forested habitats. Forested habitats in the Rocky Mountains are naturally much more fragmented than eastern or mid-western forests by steeper terrain, much greater variation in altitude, aspect and exposure, naturally integrated grasslands, and other geographic factors. For this reason, it is unknown whether a pattern of increased fragmentation correlating with increased cowbird parasitism rates found in these eastern and mid-western studies is applicable to the naturally highly fragmented landscapes of the Rocky Mountains and the Project Area. For this reason, it cannot be determined with certainty whether or not additional fragmentation from CBM development would cause increased cowbird parasitism rates in the Project Area. In addition, despite the currently heavily fragmented nature of forested habitats in the Project Area, cowbird abundance in the Project Area and in the nearby New Mexico study area (Ortega and Francis 2005) is substantially lower than in most eastern and mid-western studies (Robinson et al. 1995).

3.9.10.5 Cumulative Effects

Habitat fragmentation has the potential to significantly reduce habitat capability for migratory birds. Faaborg et al. (1998) define habitat fragmentation as occurring "where isolated remnants of once broadly occurring vegetation types exist within a matrix of dramatically altered habitat." As it is generally used, fragmentation occurs when formerly large expanses of relatively uniform habitat is converted to other habitat types to such an extent that only small fragments of the original habitat remain. In its classic sense, fragmentation causes outright loss of habitat area, an increase in habitat edge and edge effects, changes in microclimate, higher rates of nest predation, higher rates of cowbird parasitism, and lower nest success (Faaborg et al. 1998). Some species have been shown to be sensitive to small patch sizes, especially long-distance migrants.

Most studies of habitat fragmentation however, have been conducted primarily in eastern and mid-western landscapes (Faaborg et al. 1998) that are comprised primarily of naturally large contiguous tracks of densely forested habitats inhabited by bird communities adapted to large contiguous blocks of habitat. Forested habitats in the Rocky Mountains are naturally much more fragmented than eastern or mid-western forests by steeper terrain, much greater variation in altitude, aspect and exposure, naturally integrated grasslands, and other geographic factors. For this reason, it is unknown whether the fragmentation effects found in these eastern and mid-western studies are applicable to bird communities adapted to the naturally highly fragmented landscapes of the Rocky Mountains and the Project Area. Therefore, it cannot be determined with certainty whether or not additional minor fragmentation associated with CBM development would cause declines in species richness or other classic fragmentation effects. The small forest openings created by infrastructure sites and road and pipeline corridors would resemble the many openings that naturally occur throughout the Project Area due to aspect and terrain and thus are unlikely to alter habitat quality for migratory birds in any detectable way. The effect of infrastructure openings on migratory bird habitat would be long term because it would take decades after project completion before reclaimed sites return to a forested condition.

Other factors that affect habitat capability for migratory birds include timber harvesting, forest restoration, fuels reduction and fire suppression, grazing, road building, agricultural development, rural development, and recreation. Cumulatively, these activities have altered the amount, distribution, and suitability (both positive and negative) of habitat for migratory birds. For example, timber harvest over the past 60 years has converted about 1,500 acres of ponderosa pine forest on Federal land within the Project Area to other vegetation types, primarily Gambel oak, resulting in a net increase in available habitat for the mountain shrub analysis group. Together, historic fire suppression and timber harvest activities have changed the structure of ponderosa pine stands and increased the amount and density of Gambel oak and other shrub species throughout the Project Area.

Fire suppression has changed the structure of ponderosa pine and pinyon-juniper woodlands over the past 100 years and restoring the role of fire is a recommended management action for improving migratory bird habitat in western ponderosa pine forests (Rich et al 2004). In general, fire suppression has increased

the density of pine stands in the Project Area. Pine stands have become more densely stocked with smaller diameter trees, have more uniform stand structures and more closed canopies than prior to European settlement (SJNF MIS Assessment Unpub. rpt.). Increased pine stand densities have resulted in greater mortality of small diameter trees, providing increased foraging opportunities for woodpeckers in the primary cavity excavator analysis group, but the reduction in trees in the largest diameter classes (< 16 inches d.b.h.) has reduced the availability of their preferred nesting substrate. Populations of some cavity excavator species fluctuate in response to insect infestations particularly after stand-replacement fire (Andrews and Righter 1992) and therefore fire suppression has removed an important source of seasonally abundant food.

On non-Federal lands adjacent to the Project Area, past agricultural practices, increasing residential development and associated fire suppression activities have probably caused a significant expansion in mountain shrub, piñon-juniper and grassland habitats, benefiting birds of conservation concern in those analysis groups. Residential development is expected to continue in the cumulative effects area for the foreseeable future. Fuel reduction and wildfire mitigation, grazing, oil and gas development, and urban development activities are likely to continue altering the amount and condition of migratory bird habitat in the cumulative effects area. However, unless the scope of these activities changes significantly in the future, these activities are not likely to change the overall distribution of migratory bird habitats across the area.

3.9.10.6 Monitoring Suggestions:

Suggest periodic annual monitoring of surface flows, water quality and vegetation condition for at least four springs/seeps, including upper Armstrong canyon and upper Ignacio Canyon, due to their importance for riparian/wetland birds of conservation concern and the uniqueness of their associated habitats for migratory birds.

3.9.11 Unavoidable Adverse Effects

Unavoidable adverse effects are adverse effects that would occur because of the proposed project despite implementation of mitigation measures designed to minimize adverse effects. Portions of wildlife habitats, including community types and habitat structural stages, would be degraded or removed. Small amounts of wetlands and riparian areas would be degraded or removed. Portions of old growth stands of ponderosa pine would be removed. Post-project restoration would not be completely successful in replacing lost vegetation, at least not for a period of decades to several centuries. Infestations of noxious weeds would increase and displace native vegetation in areas. Fire regimes would be altered. Portions of potential habitats for special status plant species would be lost.

3.9.12 Irreversible and Irretrievable Commitment of Resources

Loss of old growth stands of ponderosa pine beyond the life of the project would be an irreversible commitment because restoring functional old growth habitat for wildlife would be an extremely long-term process.

Loss of vegetative cover until reclamation is successful, late-seral habitat structural stages beyond the life of the project, riparian and wetland vegetation over the life of the project, potential habitats for special status plant species, and decreased productivity of native plant communities because of increased infestations of noxious weeds would be irretrievable commitments.

3.10 Land Use

3.10.1 Issues

Issue 7: The effects of additional CBM development on agricultural and residential land uses.

- Is the proposed project consistent with the adopted land use plans and policies of federal, state, and local agencies?
- How will CBM affect existing land use, agriculture, and livestock/range conditions?
- How do private property owners participate in the development of surface use plans designed to protect surface resources?

Issue 17: The effects of additional development on the HD Mountains Inventoried Roadless Area and roadless lands in general.

- How will CBM development affect the Archuleta Mesas portion of the Project Area?

3.10.2 Affected Environment

3.10.2.1 Ownership

The Project Area encompasses 125,000 acres of land (195 square miles). Most of the surface in the Project Area is privately owned (Table 3-110). The federal government owns almost 45 percent of the surface area, and the State of Colorado owns a small portion of the surface in the Project Area.

Table 3-110 Distribution of Surface Ownership by Owner and County

Surface Ownership	Area by County: La Plata (acres)	Area by County: Archuleta (acres)	Extent (acres)	Portion of Project Area (percent)
Federal BLM	6,672	0	56,056	44.7
Federal NFS	20,008	29,376		
State	4,101	362	4,463	3.6
Private	60,495	4,334	64,829	51.7
Total	91,276	34,072	125,348	100.0

The pattern of surface ownership is distinctly different in the western and eastern portions of the Project Area. Surface ownership in the western half of the Project Area consists primarily of private property heavily intermingled with federal (BLM) and state lands (Figure 3–37). The intermix of private residences and gas development within La Plata County creates greater potential for landowner disputes and impacts due to proximity of wells to private residences. The BLM San Juan Center administers the federal lands within the San Juan/San Miguel Planning Area. The eastern half of the Project Area is mostly federal land within the SJNF, administered by the FS Columbine Ranger District.

Overall, the pattern of mineral ownership is similar to surface ownership, except that the federal and private categories are reversed (Table 3-111). About 46 percent of the mineral estate is privately owned, and 50 percent of the mineral estate within the Project Area is federally owned. Most of the privately owned mineral estate is in the western portion of the Project Area (Figure 3–38). BLM manages the federal mineral estate for both BLM and NFS lands. Therefore, 50 percent of the mineral estate within the Project Area is under BLM's jurisdiction.

Table 3-111 Classes of Mineral Ownership in the Project Area

Surface/Mineral Jurisdiction	Areal Extent (acres)	Percent of Mineral Ownership	
BLM Surface/Federal Mineral	6,711		
National Forest Surface/Federal Mineral	47,368	Federal	50
Private Surface/Federal Mineral	8,567		
Private Surface/Private Mineral	56,216	Private	46
Federal Surface/Private Mineral	2,024		
State Surface/State Mineral	4,460	State	4
Total	125,346		100

Six classes of mineral and land ownership occur within the Project Area, as shown on Figure 3–38 and summarized on Table 3-111. Some of the properties within the Project Area are "split estate," meaning that the owners of the surface and mineral rights are different. For example, the surface may be privately owned, but the mineral estate is federally owned.

3.10.2.2 Existing Land Uses

Existing land uses within the Project Area were mapped using information from La Plata and Archuleta Counties. Figure 3–39 shows the distribution of the categories of primary land use identified in the Project Area, and Table 3-112 shows the areal extent of each category. The predominant land uses within the Project Area are agricultural/rangeland and undeveloped lands. Undeveloped lands include federal or state lands that are generally available for rangeland, dispersed recreation, timber management, and mineral leases. The primary transportation corridors within the Project Area are discussed in the Transportation section of this chapter.

3.10.2.2.1 Undeveloped Land

Undeveloped areas within the Project Area consist primarily of federal lands and, to a lesser extent, some state open lands are also in this category. The BLM and Forest Service manage public lands for multiple uses, including such concurrent uses as rangeland under permitted grazing allotments, dispersed recreation, timber management, and mineral development.

Approximately 53 percent of the Project Area is currently in the undeveloped land use category. Most of the undeveloped land in Archuleta County is within the SJNF, and almost half of this undeveloped land is used as rangeland under permitted grazing allotments (FS 1983). Some of the lands classified as undevel-

oped by Archuleta County is actually agricultural land, particularly along the Piedra River Corridor. The BLM and NFS lands in La Plata County are also included in the undeveloped land use category. The FS and BLM have not attempted to correct county land use maps, but the categories depicted present a good general description of the various land use categories.

Table 3-112 Areal Extent of Existing Land Uses in the Project Area

Category of Land Use	Areal Extent La Plata County (acres)	Areal Extent Archuleta County (acres)	Areal Extent Project Area (acres)	Portion of Project Area (Percent)
Undeveloped[1]	33,008	31,266	64,274	51.3
Agriculture/Rangeland	31,146	2,544	33,690	26.9
Residential	25,363	204	25,567	20.4
Urban	1,758	59	1,817	1.4
Total[2]	91,275	34,073	125,348	100.0

Notes:
1. Undeveloped federal lands (BLM and NFS) are generally used as rangeland under permitted grazing allotments, and for other multiple uses such as dispersed recreation.
2. Totals may not match precisely with values obtained by adding unit numbers because of rounding conventions.

Dispersed recreation is emphasized in the Grandview Ridge and Horse Gulch Trails area, located primarily on BLM lands in La Plata County, and in several county open space and recreational areas.

3.10.2.2.2 Agriculture/Rangeland

The agriculture/rangeland category of land use includes both farmland used for producing crops and rangeland used for grazing livestock. It also includes some rural residential properties.

The agriculture/rangeland category encompasses 25 percent of the Project Area (Table 3-112). Within the Project Area, most of the land in this category is rangeland used for grazing livestock. The rest of the agricultural land is used as farmland for producing crops.

A small portion of the farmland in the Project Area is considered prime farmland. The prime farmland designation is based on soil type, regardless of current land use. The prime farmlands in the Project Area are composed of irrigated soils in a small area along the upper section of the Florida River and near Bayfield. Impacts to date that have affected prime farmlands are discussed in the Soils section of this chapter.

The BLM and NFS lands in the Project Area are generally available as rangeland for livestock under permitted grazing allotments. A grazing allotment is an area of land designated and managed for the grazing of livestock by one or more livestock operators. The number of livestock (stocking rate or carrying capacity) and period of use are stipulated for each allotment. The carrying capacity is an estimate of the maximum number of animals (expressed in AUMs) a given area can

support each year without damage to vegetation or related resources. One AUM is the amount of forage necessary to support one animal-unit for one month. An animal-unit is a 1,000-pound cow typically consuming 780 pounds of air-dry forage for one month.

Grazing allotments are managed and multiple land uses are coordinated to maintain healthy public lands. The San Juan/San Miguel Planning Area RMP and amended RMP (BLM 1985, 1991), and the Decision Record for the Standards for Public Land Health and Guidelines for Livestock Grazing Management (BLM 1997) apply to development on BLM lands. The standards and guidelines for the NFS lands in the Project Area are provided in the SJNF LRMP and amended LRMP (FS 1982, 1992). These standards and guidelines are also discussed in the Vegetation section of this chapter.

The Project Area contains entire, or portions of, 7 BLM grazing allotments and 10 FS grazing allotments (Figure 3–40). Livestock grazing is permitted on 5 of 7 BLM allotments and 7 of 10 FS allotments. On BLM lands, 300 AUMs are permitted for livestock grazing and on NFS Lands, 2,899 AUMs are permitted. Table 3-113 displays permitted use and grazing allotment management. Grazing is permitted on approximately 68 percent of public lands within the Project Area. Due to the steep, rugged terrain, livestock can graze only about 35 percent of NFS lands within the Project Area. BLM lands are generally more accessible within the Project Area.

Table 3-113 Affected Grazing Allotments within the Project Area

Allotment	Owner	Status	Areal Extent (acres)	Permitted AUM[1]'s	Grazing Season	Management
Palmer	BLM	Vacant	745	0	na[2]	na
Florida River	BLM	Active	847	102	3/1 – 2/28	Season-long
W. Rabbit Mtn.	BLM	Active	160	21	6/1 – 10/31	Season-long
Wallace Gulch	BLM	Vacant	1,847	0	na	na
North Canby	BLM	Active	40	6	5/16 – 6/30	Season-long
Mahan	BLM	Active	1,120	161	6/1 – 9/30	Season-long
South Canby	BLM	Active	86	6	6/1 – 10/30	Season-long
Little Bear	FS	Active	3,237	57	5/16 – 6/15	Rotational
Shaefer Mtn.	FS	Vacant	3,413	0	na	na
Bonnell Cyn.	FS	Active	6,142	121	6/2 – 10/15	Rotational
Sauls Creek	FS	Active	13,595	395	5/16 – 6/30	Rest-Rotation
HD	FS	Active	22,087	506	5/21 – 6/25 and 10/6 – 10/12	Rest-Rotation
Mosca	FS	Active	15,034	1200	6/26 – 10/5	Rotational
Freeman Creek	FS	Active	13,826	455	6/1 – 10/15 and 10/16 – 10/30	Rotational
Turkey	FS	Active	12,185	165	5/16 – 6/30	Rest-Rotation
Turkey Exclosure	FS	Vacant	14,624	0	na	na
Chimney Rock	FS	Vacant	21,754	0	na	na
Total			130,742	3,199		

Notes:
1. An animal unit factor of 1.32 is used on NF lands due to the forage demand by an adult cow with offspring.
2. na = not applicable

Grazing management on BLM lands is directed either at maintaining current satisfactory resource conditions and preventing resource deterioration (BLM 1984b). Grazing allotments are generally small and scattered amongst larger private land parcels. Season-long grazing systems are in place. There are no pastures within allotments. With the exception of the Mahan allotment, all BLM grazing allotments contain 100 percent public land ownership. Range conditions are generally fair and estimated trend is stable.

Grazing management on NFS lands is directed at achieving and maintaining satisfactory range conditions. On an individual grazing allotment basis, livestock management is directed at meeting a range of resource objectives including satisfactory riparian conditions, big game winter range, dispersed recreation, and livestock production (FS 1992). Rotational grazing systems, utilizing fences and natural topographical features to separate allotments into pastures, are used to meet grazing management objectives. Range conditions are generally good and trend is stable to improving.

Much of the public land within the Project Area is inaccessible due to steep slopes, poor forage production, and dense brush. Primary range available for grazing is mainly sagebrush grasslands on bottomlands and valleys and secondary range comprised of ponderosa pine forests, pinyon-juniper woodlands, and Gambel oakbrush scrub. Main forage species are: western wheatgrass, Kentucky bluegrass, junegrass, bottlebrush squirreltail, needlegrasses, and brome grasses. Range improvements have included sagebrush clearing and re-seeding, fence construction, cattleguard installation, water developments, and erosion control features (FS and BLM 1992). In addition, other vegetative improvement projects that have been undertaken on public lands include prescribed burning, timber thinning, and hydromowing.

The allotments in the SJNF are currently managed with rotation grazing systems. Some allotments are used only 30 days in the spring, and others are used the entire season with deferment of pastures during certain periods of the growing season. Stock ponds, herding, salting, fencing, and geographical barriers are the primary means of controlling livestock distribution. The range analysis summaries show an upward trend in terms of species composition and cover.

3.10.2.2.3 Residential Land

The county-designated land use maps define three categories of residential land use within the Project Area: rural residential, existing subdivisions, and proposed subdivisions. Residential development includes single-family and multi-family dwellings and mobile homes. About 20 percent of the Project Area is classified in residential the land use category (Table 3-112). Some residential land uses are also included within county-designated urban land.

3.10.2.2.4 Urban Land

Urban land uses are defined as commercial, public, and institutional facilities, industrial facilities, mines, and roads. In addition, the City of Durango has designated several "potential urban areas" within the Project Area that may be provided urban services, such as water and wastewater disposal (Hoch 2003). These areas may be subject to city annexation. These potential urban areas are primarily

concentrated in the areas southeast of the city, near the intersection of U.S. Highway 550 and U.S. Highway 160. La Plata County also has designated similar areas around the Town of Bayfield. Mines include several inactive or abandoned coal mines and active sand, gravel, and aggregate mines. This category of land use encompasses only a small portion of the Project Area (Table 3-112).

3.10.2.2.5 Existing Oil and Gas Development

The existing oil and gas development shown on Figure 3–39 has displaced some uses through construction of oil and gas facilities in areas that previously supported other types of uses. As of the end of 2002, existing oil and gas facilities had converted a total of 553 acres (just less than 1 percent of the Project Area) to oil and gas facilities. The existing facilities include 323 CBM wells, 13 conventional oil and gas wells, 6 disposal wells, and 4 compressor stations.

Existing CBM wells are not uniformly distributed across the Project Area. Most of the wells (75 percent) are on private lands within La Plata County. More than 54 percent of the wells on private agricultural lands involve lands that are classified as rangeland and are used for grazing livestock and cattle. Less than 1 percent of the wells are on farmlands used for producing crops. About 23 percent of the wells are on private rural residential properties.

The areal extent of impact to the land use categories caused by existing CBM facilities parallels their distribution. For example, existing oil and gas facilities have displaced 267 acres of agricultural land, which is less than 1 percent of the agricultural land present in the Project Area. Oil and gas facilities have displaced less than 80 acres of residential land (1 percent of the residential land in the Project Area).

Many of the existing oil and gas facilities are located along transportation corridors, such as U.S. Highways 160 and 172 between Durango and Ignacio. Some CBM facilities are visible from corridors that also serve as primary routes for visitors to the area.

3.10.2.3 Land Use Plans and Policies

Oil and gas development within the Project Area must comply with the land use plans and policies adopted by federal, state, and county governments. A summary of the applicable current plans and policies is provided in this section.

3.10.2.3.1 Federal Land Management

BLM- and FS-administered federal lands are generally available for oil and gas leasing, exploration, and development. The San Juan/San Miguel RMP and EIS and amended RMP (BLM 1984a, 1984b, 1991) and the Colorado Oil and Gas Leasing EIS (BLM 1991) provide guidelines for use of the BLM-administered federal lands and federal mineral estate in the Project Area. The SJNF LRMP (FS 1983) and the amended LRMP (FS 1992) provide guidelines for energy mineral development on the National Forest.

BLM is responsible for issuing and managing leases that involve federal minerals, regardless of surface ownership. BLM is also responsible for conducting an environmental analysis on BLM lands (BLM surface ownership), preparing the

documentation, and specifying the mitigation measures to protect surface resources for approval of an APD. The FS responsibilities are similar on NFS lands. BLM is responsible for approval of the drilling program, protection of groundwater and other subsurface resources, and final approval of the APD on both BLM and NFS lands with federal minerals. Within the SJNF, the FS authorizes surface use plans for oil and gas developments.

A COGCC drilling permit is required for wells on private and state mineral estates.

3.10.2.3.2 State Land Management

State-owned lands in the Project Area are generally available for mineral and agricultural leasing, timber sales, dispersed recreation, and open space. Land use goals for most of the state lands within the Project Area include oil and gas development. There are no state parks or state wildlife areas within the Project Area.

COGCC rules (COGCC 2002b) apply to drilling and operating oil and gas wells on private or state mineral estates. These rules require setbacks with respect to distance of wellheads from lease lines, surface property lines, other producible oil or gas wells, occupied buildings, public roads, major aboveground utilities or railroads, and existing coal mines, unless authorized by order of the COGCC. These setback distances are designed to address safety issues and to minimize potential conflicts between the wells and adjacent land uses.

3.10.2.3.3 County and Municipal Planning and Land Use Controls

Local government regulations apply to CBM development on private lands. Oil and gas development on private lands within unincorporated La Plata or Archuleta Counties must comply with the county land use regulations, as summarized in the following subsections.

La Plata County

Development on private lands within unincorporated areas of La Plata County must comply with the La Plata County Land Use Code (La Plata County 1997, currently under revision as of October 2005). Although no zoning regulations currently are in place for the portion of the County within the Project Area, the existing use of the surface and surrounding land uses determine the County's system for permitting. The land use code effectively serves as a zoning code and a system for permitting and regulating development in La Plata County. Specifications and standards for development and performance are included in the code. The County is currently evaluating and rewriting the code.

The County also recently developed a La Plata County Comprehensive Plan (La Plata County 2001). The goal of the comprehensive planning process is to provide a Countywide guide to growth using the land use plans established by the planning districts.

In 1990, the County added specific regulations to its land use system for both "minor" and "major" oil and gas facilities on private lands (Chapter 73 of the Code, Ordinance No. 2000–32). A "minor" oil and gas facility is "an individual

well site built and operated to produce petroleum and/or natural gas (methane), including auxiliary equipment required for production, and other equipment located within the perimeter of the well site pad…" In addition, a compressor with less than 200 horsepower is a minor facility. Larger compressor stations are major oil and gas facilities and require a public hearing before a permit can be approved. Section 90–52 of the code requires that operators submit an Emergency Preparedness Plan.

Archuleta County

Archuleta County has no jurisdiction over development in most of the Project Area because it is predominantly federal land within the SJNF. Figure 3–37 shows the portion of the Project Area that is NFS land within the SJNF. Very little private land or existing or proposed residential developments are within this area.

Development on private lands in the unincorporated part of the County must comply with the Archuleta County Land Use Regulations and may require a conditional use permit (Archuleta County 2000). These regulations define conditional uses as land development, including mining or extraction that has the potential to cause adverse impacts on other land uses. A conditional use permit is required for major oil and gas facilities. The intent of the conditional use permit process is to ensure that the location and operation of the proposed land use will not be detrimental to other uses or properties (Archuleta County 2000, 2001).

The current development trends for Archuleta County suggest that no urban growth is likely within the Project Area. Most of the predicted growth, including proposed subdivisions, would be located east of the Project Area near Pagosa Springs.

3.10.2.3.4 Surface Land Use Plans and Participation by Private Property Owner

The landowner has full control over the location of CBM facilities for properties in which the landowner holds surface and mineral rights. Landowners that do not own the mineral rights cannot prevent mineral lessees from drilling a well on the property. However, owners of private lands where mineral rights are owned and controlled by the federal government have opportunities to participate in developing surface use plans through the BLM, FS, and county permitting processes. More than half the lands in La Plata County are split estate with privately owned surface that overlie the Fruitland Formation (Hammer, Siler, George Associates 1990).

BLM must analyze and approve each component of CBM development on a site-specific basis when federal mineral leases are involved. The method used to evaluate each surface-disturbing activity is the APD, ROW Grant, or SUPO, which must be approved before construction can begin. The APD includes a surface use program and a drilling plan, as identified in Onshore Oil and Gas Order No. 1 and at 43 CFR 3162.3. The proposed well, access road, and pipeline locations, and other areas of proposed surface land use are inspected on site before the application can be approved. For split estate lands (land with private surface ownership and federal minerals ownership), the surface owner is invited to attend

the on-site inspection and has the opportunity to provide input on where the facilities would be located.

The on-site inspection identifies potentially sensitive areas and the environmental consequences associated with the proposal at each specific location. It focuses on site-specific methods needed to mitigate environmental effects. After the site inspection, the APD may be revised and additional site-specific mitigation added as Conditions of Approval (COAs) to the APD, consistent with the terms of the lease, to protect the value of surface or subsurface resources near the proposed activity. These conditions usually include adjusting the proposed locations for well sites, roads, and pipelines; identifying the construction methods to be employed; and establishing additional mitigation and reclamation standards.

Surface use and ROW on private lands must also be approved by state, county, and municipal agencies. Access or surface use agreements are negotiated with surface owners or secured through the permitting processes of the federal, state, or local jurisdictional agencies. Surface owners are generally compensated for the value of split estate lands that are displaced by CBM facilities.

The county land use permit process is designed to reduce impacts from the proposed facilities on private lands within unincorporated portions of La Plata or Archuleta Counties and defines required mitigation measures. A permit for either a minor or major oil and gas facility must be obtained for CBM development on private land within unincorporated La Plata County. The permit application for an oil and gas facility requires the applicant to specify measures to minimize surface damage and degradation of visual resources. A minor oil and gas facility permit is required for an individual CBM well. A major oil and gas permit would be required for a compressor station, and a public hearing is required.

Development of a major oil or gas facility on private lands in unincorporated Archuleta County requires a conditional use permit. This permit is intended to ensure that the location and operation of the proposed use will not be detrimental to other uses or properties. A public hearing is required for a conditional use permit.

3.10.2.3.5 Unroaded Lands within the Project Area

A portion of the NFS lands in the Project Area are defined by the Forest Service as unroaded lands (Figure 2–5). The HD Mountains Roadless Area (RARE II designation) forms the core of the HD Mountains portion of the Project Area. The official Inventoried Roadless Area is approximately 20,010 acres in size and was delineated using roadless criteria established through the 1979 Roadless Area Review and Evaluation (RARE). The FS has reinventoried the Project Area to determine if there are any changes over the past 25 years. The criteria used to make this re-determination are somewhat different from the original inventory. Now, unclassified roads are included in unroaded area, whereas during RARE II, the presence of classified and unclassified roads excluded areas from roadless designation. A total of 27,796 acres are now described as unroaded lands based on the physical characteristics of the land and the current transportation system (Figure 3–44). The 27,796-acre unroaded area presents a boundary that is somewhat different from the original roadless area boundary. Each of the alternatives

would affect unroaded land within the Project Area. Most of the unroaded lands are leased for energy mineral development.

The unroaded area provides a variety of values and uses including unfragmented habitat for wildlife, watershed that contributes to clean lakes and streams, dispersed recreation — primarily hunting, ATV use, camping (generally associated with hunting), sightseeing, and fishing. Seasonal big game hunting is the major attraction to the HD Mountains Area. There are two CBM wells in the HD Mountains Roadless Area and a Forest Service Road (FSR 756) that splits the Roadless Area, providing access to an existing gas well and trails at the top of the HD Mountains.

There is a long chronology of FS decisions that have shaped the HD Mountains Roadless Area's management. The 1979 RARE II recommended continued management of HD Mountains Inventoried Roadless Area for non-wilderness, multiple use activities. The 1983 ROD for the LRMP for the SJNF continued the theme of managing the HD Mountains Roadless Area for multiple-uses including oil and gas development.

The following chronology summarizes the timing and status of land management decisions relevant to the HD Mountains Roadless Area:

- Early 1970s – USGS identifies the SJB as having high potential for oil and gas development including the HD Mountains.
- 1974–77 – Large portions of the HD Mountains are leased for oil and gas development.
- 1977–79 – RARE II identifies 20,010 acres of the HD Mountains as an Inventoried Roadless Area. Oil and gas leases issued during this period are issued with NSO stipulations.
- 1979 – RARE II recommends that the HD Mountains Inventoried Roadless Area not be included in the National Wilderness Preservation System.
- 1980 – The Colorado Wilderness Act does not include the HD Mountains Roadless Area in the National Wilderness Preservation System.
- 1980 – The Energy Security Act directs the Secretary of Agriculture to process leases on NFS lands regardless of the status of any ongoing planning efforts.
- 1981 – The NSO stipulations are rescinded for leases issued during the RARE II evaluation process.
- 1983 – The ROD for the LRMP for the SJNF reaffirms that the HD Mountains are available for and to be managed for multiple uses other than wilderness.
- 1992 – The EIS for the HD Mountains Coalbed Methane Gas Field Development Project analyzes development of 95 coal bed methane gas wells. The ROD approves APDs for 16 wells and associated facilities and establishes a programmatic gas field development plan that would develop portions of the HD Mountains Roadless Area.

- 1993 – The Colorado Wilderness Act of 1993 designates certain lands within the SJNF for inclusion into the National Wilderness Preservation System. The HD Mountains Roadless Area is not included in the Act.

Each of these previous decisions and leasing actions affirmed that the HD Mountains Roadless Area's availability for multiple use management, and the issuance of leases within the Area, both before and after RARE II, reflected the FS management intent.

The RACR was adopted on January 12, 2001 and was replaced by a new Rule in 2005. The Rule placed prohibitions on road construction and surface development when leases may be issued subsequent to the Rule's adoption. However, the vast majority of leases within the HD Mountains Roadless Area predate the Rule and, therefore, are subject to prior existing rights and the standard stipulation to which they were assigned. Two leases issued after January 12, 2001, COC64935 and COC64936, were issued with no-surface-occupancy stipulations, consistent with the 2001 rule. The chronology of legal challenges to the Rule and of Agency revisions to the Rule follow:

- January 12, 2001 – The "Final" RACR is adopted. It recognizes the prior existing right of lessees to develop oil and gas resources under existing leases, including road building.
- 2001 – The Roadless Rule is challenged in nine separate lawsuits in federal district courts in Idaho, Utah, North Dakota, Wyoming, Alaska, and the District of Columbia.
- May 10, 2001, the Idaho Federal District Court issues a preliminary injunction order prohibiting USDA and the FS from implementing the Roadless Rule. This action is appealed to the Ninth Circuit Court of Appeals by interveners in the Idaho cases.
- December 12, 2002, the Ninth Circuit Court of Appeals issues a split 2–1 decision on the appeal of the Idaho District Court's preliminary injunction reversing and remanding that action. Plaintiffs in the Idaho cases request that the Ninth Circuit reconsider this decision utilizing the full 10 judge panel. The Ninth Circuit declines this request on April 4, 2003, and issues its mandate to the Idaho District Court reversing and remanding the lower court's action on April 14, 2003.
- April 14, 2003, the Ninth Circuit Court of Appeals issues a mandate to the Idaho Federal District Court to dissolve its preliminary injunction and proceed to a trial on the merits. This event actually made the roadless rule effective for the first time.
- June 9, 2003, USDA announced that it will implement the roadless rule but would be proposing an amendment to it to identify how Governors may seek relief from the prohibitions of the rule for limited exceptional circumstances within their State.
- June 9, 2003, USDA settles a lawsuit with the State of Alaska on the roadless rule by agreeing to publish a proposed rule to temporarily exempt the Tongass National Forest from the prohibitions of the rule. This proposed rule is published for public notice and comment on July 15, 2003.

- July 14, 2003, the U.S. District Court for the District of Wyoming finds the roadless rule to be unlawful and orders that the rule "be permanently enjoined". That ruling has been appealed to the Tenth Circuit by interveners.
- May 11, 2004, the Tenth Circuit Court of Appeals agrees to hear the appeal of the Wyoming District Court's July 14, 2003, order to permanently enjoin and set aside the roadless rule.
- July 12, 2004, USDA announces that it is publishing for public review and comment a proposed a rule that would replace the 2001 roadless rule with a petitioning process that would allow Governors an opportunity to seek establishment of or adjustments to management requirements for NFS inventoried roadless areas within their States. In addition, the FS announces that it is reinstating the interim protection measures for inventoried roadless areas that expired on June 14, 2003.
- May 13, 2005 – After review and consideration of public comment received on the proposed rule, the USDA revises Subpart B of Title 36, CFR, Protection of Inventoried Roadless Areas, by adopting a new rule that establishes a petitioning process that will provide Governors an opportunity to seek establishment of or adjustment to management requirements for NFS inventoried roadless areas within their States. The opportunity for submitting State petitions is available for 18 months following the effective date of this final rule. Under this final rule, submission of a petition is strictly voluntary, and management requirements for inventoried roadless areas would be guided by individual land management plans until and unless these management requirements are changed through a State-specific rulemaking.

Thus, the baseline management direction for inventoried roadless areas are those that exist in currently approved land management plans. It is these management requirements that Governors could petition to adjust. If no petition is submitted, these management plan requirements would remain unchanged subject to amendment or revision under the National Forest Management Act (NFMA) planning procedures at 36 CFR Part 219. The NSO stipulations assigned to leases COC64935 and COC64936 that are in the Roadless Area are waivable, in whole or in part, consistent with the management direction of the current LRMP and the stipulations placed on the leases at the time they were issued. All other leases were issued with standard stipulations and are unaffected by the new Rule, and would have been unaffected by the old Rule if it were still valid.

As part of the LRMP revision process, roadless areas are reviewed for wilderness suitability. The HD Mountains Roadless Area, along with all other roadless areas on the SJNF, will be the subject of such review, which should be concluded by 2007. During the interim, portions of mineral leases may be developed, altering the size of the land area that would be subject to review. Section 3.10.3.2 of this chapter addresses the level of development that would occur within the unroaded area by alternative.

3.10.2.3.6 No-Surface-Occupancy Leases

Five leases, COC64932 through COC64936, were issued in May 2001 with NSO stipulations. As specifically stipulated in the five leases, conditions requiring the

continued use of special stipulations on these leases would be examined in this EIS. The no-surface-occupancy stipulations would remain in effect until this EIS is completed. At such time, as expressly described in the ROD for this project, the NSO stipulations may be waived, excepted or modified, or remain in full force and effect. This EIS provides the basis for final determination of application of lease stipulations to these five parcels.

Lease COC64932 overlays the Archuleta Mesas area that was identified in 1997 as a potential research natural area as part of the land and resource management planning (LRMP) process. The LRMP revision is in the developmental stage and LRMP recommendations regarding Archuleta Mesa's management should be completed by 2007. The companies' propose to develop seven wells within this lease area. This proposal will be acted in the ROD for this project.

Leases COC64935 and COC64936 are within the HD Mountains Inventoried Roadless Area. Portions of these two leases are characterized as having steep slopes that may suggest continuation of no surface occupancy. Other portions of the two leases contain slopes that could reasonably accommodate surface occupancy. The final RACR provides that roadless areas be managed according to their current LRMPs. Accordingly, there is no prohibition against surface occupancy and the NSO stipulations that apply to these two leases. As described in the lease stipulations, no surface occupancy may be waived, excepted, or modified in the record of decision for this project. The companies' propose nine wells within these two lease parcels.

Two remaining NSO leases, COC64933 and COC64934, are located in the eastern portion of the HD Mountains. Small portions of the two leases also contain steep slopes on which surface development is not proposed. Other portions of the leases have proposed development. The companies propose to drill thirteen wells on these two leases

3.10.2.3.7 Ignacio Creek and Archuleta Mesas — Potential Research Natural Areas

In 1996, the FS, with assistance of the Colorado Natural Areas Program staff, conducted an inventory of potential research natural areas (RNAs) on the SJNF. A total of 21 areas were identified as containing attributes that may warrant further evaluation of RNA potential during the land and resource management planning process Two of these areas, Ignacio Creek (6,193 acres) and Archuleta Mesas (6,820 acres), are within the Project Area.

Ignacio Creek's topography is characterized by steep slopes formed by fluvial processes. The potential RNA encompasses most of the Ignacio Creek drainage. Cover types are represented across a broad elevational spectrum. Mixed conifer forests dominated by ponderosa pine, white fir, and Douglas-fir cover most of the area. Stands of pinyon-juniper woodlands occur on drier, sandier slopes at low elevations. Oak shrublands are found throughout the potential RNA and deciduous forests occupy the riparian zone along Ignacio Creek. Grasslands, some of which have a significant sagebrush component, are scattered along the terraces above the east bank of Ignacio Creek. The entire Ignacio Creek potential RNA is leased for mineral development and the companies propose to develop portions

of their leases within the area. CBM development of the Ignacio Creek area will be determined in the Record of Decision for this project.

The Archuleta Mesas potential RNA includes two blocks of potential RNA that were formerly split into Archuleta Creek and Deep Canyon. The area provides lower montane forest, woodland, and shrubland ecosystems. The BLM issued the Archuleta Mesa's lease COC–64932 (1,680 acres) in May 2001 with a no-surface occupancy stipulation to remain in effect pending completion this EIS. The companies propose to develop seven wells within a portion of the Archuleta Mesas potential RNA. CBM development of the Archuleta Mesas area will be determined in the ROD for this project.

3.10.3 Environmental Consequences

This section analyzes how the alternatives may affect existing land uses within the Project Area and whether the project would be consistent with the land use plans and policies adopted by the federal, state, and local jurisdictions.

3.10.3.1 Land Use

The proposed CBM development would affect existing land uses on all jurisdictions in the Project Area in several ways. First, some existing land uses would be displaced by surface disturbances during both the construction and operation phases of the project. These impacts would generally occur for the life of the project as well as after the project, since some area would not be fully reclaimed to original condition.

Second, land uses near CBM facilities would be affected by intrusive effects. For example, CBM-related vehicles on existing roads would generate additional noise, dust, and traffic. These effects would conflict with nearby land uses, primarily residential properties.

Third, the proposed CBM facilities may affect growth patterns, possibly resulting in conflicts with county goals for future land use. Impacts to visual resources, noise, dust, recreation, transportation, and potential effects to residential property values are analyzed in other sections of this chapter.

The distribution of proposed CBM facilities across the categories of land uses is shown on Figure 3–41. The number of proposed CBM wells within each land use category is listed in Table 3-114. Most of the proposed CBM wells would be located on undeveloped land, a county-designated land use category. This category consists primarily of federal lands (BLM and National Forest). In addition, some State open lands are in this category. Most of the undeveloped land in Archuleta County is within the SJNF and available as rangeland for livestock under permitted grazing allotments.

Land use impacts would vary depending on surface and mineral ownership at the specific locations of CBM facilities. Landowners who own all of the mineral rights for the property are able to decide whether to allow CBM development on the land. The landowner has full control over the location of CBM facilities for properties with both surface and mineral rights.

Table 3-114 New CBM Wells by Land Use Category and Alternative

Land Use Category	Number of New CBM Wells by Alternative				
	1	2	5	6	7
Project Area					
Undeveloped	200	365	30	94	153
Agricultural					
Rangeland	28	59	29	28	28
Farmland	17	23	16	17	17
Residential					
Rural Residential	11	13	10	11	11
Existing Subdivision	14	28	19	14	14
Proposed Subdivision	10	22	10	10	10
Urban and Roads	4	4	3	4	4
Total	284	514	117	178	237
Total No. of Well Pads	261	491	117	176	226
National Forest					
Undeveloped	170	284	15	67	123
Agricultural					
Rangeland	2	2	0	2	2
Farmland	0	0	0	0	0
Residential					
Rural Residential	0	0	0	0	0
Existing Subdivision	0	0	0	0	0
Proposed Subdivision	0	0	0	0	0
Urban and Roads	1	1	0	1	1
Total	173	287	15	70	126
Total No. of Well Pads	150	264	15	68	115
BLM (including split estate)					
Undeveloped	15	25	0	13	15
Agricultural					
Rangeland	6	16	6	6	6
Farmland	0	0	0	0	0
Residential					
Rural Residential	2	3	1	2	2
Existing Subdivision	2	6	2	2	2
Proposed Subdivision	1	1	0	1	1
Urban and Roads	1	1	0	1	1
Total	27	52	9	25	27
Total No. of Well Pads	27	52	9	25	27

Land use conflicts are most likely to occur where CBM wells are located on split estate properties that have private surface ownership without mineral estate ownership (severed minerals). In some cases, landowners are not aware of the severed mineral rights until they receive a notice that the lessee intends to drill a well on the property. The specific locations for CBM facilities would be negotiated with landowners on split estate lands. Surface owners would generally be

compensated for the value of land displaced by CBM facilities. However, there have been conflicts between some surface and mineral estate owners over the adequacy of compensation. There most likely would be additional disagreement as CBM development proceeds on private land.

A limited number of CBM facilities are proposed on split-estate properties with private surface ownership. All of the proposed wells on split-estate lands with private surface ownership are located in La Plata County. No CBM facilities are proposed on private split-estate properties in Archuleta County. Table 3-115 shows the number of proposed CBM wells to be located on split-estate properties by land use category.

Table 3-115 New CBM Wells on Private Split-Estate Land, by Alternative

Land Use Category	Number of New CBM Wells by Alternative				
	1	2	5	6	7
Undeveloped	1	2	0	5	5
Agricultural					
Rangeland	5	7	6	6	6
Farmland	6	16	0	0	0
Residential					
Rural Residential	0	0	1	2	2
Existing Subdivision	2	3	2	2	2
Proposed Subdivision	2	5	0	0	0
Urban and Roads	0	0	0	0	0
Undeveloped	0	0	9	0	0
Total	15	31	5	15	15

There are two main CBM related environmental consequences affecting grazing management: temporary loss of available forage for livestock, as expressed in the short-term (0 to 10 years) and long-term (11 to 30 years), and impacts to natural boundaries due to road and ancillary facility construction. As road and other facility locations are proposed, it is difficult to determine how many miles of fence would be needed to mitigate the loss of natural pasture and allotment boundaries. Therefore, these impacts would require mitigation on an allotment-by-allotment basis.

Temporary forage loss expressed in AUMs, by alternative, is shown on Table 3-116 below. AUMS lost are calculated by multiplying disturbed acres by percent of allotment acres suitable for livestock grazing, and dividing by the allotment stocking rate on suitable lands. There is no livestock forage on vacant or non-stocked allotments. On BLM grazing allotments, suitable grazing lands are estimated at 80 percent of allotments acres.

In addition to the ownership-related considerations discussed previously, the duration of the land disturbances were considered for the analysis of land use impacts from the proposed project. Table 3-117 shows the estimated acres of surface disturbance within each land use category by surface ownership for the alternatives. Construction of CBM facilities would involve land conversion for

well pads, compressor stations, access roads, pipelines, and disposal wells. After construction, pipelines and portions of the well pads, or other facilities not needed for production, would be reclaimed. The remaining acres of disturbance would be displaced for the productive life of the project until decommissioning and final reclamation occurs. The dedicated facilities would represent conversion of the pre-project resources to CBM-related uses for the life of the project.

Table 3-116 Temporary Forage Losses on Stocked Grazing Allotments

	Loss of Forage by Alternative (AUMs)									
	1		2		5		6		7	
Active Grazing Allotment	Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term	Short-Term	Long-Term
Florida River - BLM	0	0	4	3	0	0	0	0	0	0
West Rabbit Mtn. - BLM	0	0	0	0	0	0	0	0	0	0
North Canby - BLM	0	0	0	0	0	0	0	0	0	0
Mahan - BLM	0	0	0	0	0	0	0	0	0	0
South Canby - BLM	0	0	0	0	0	0	0	0	0	0
Little Bear - FS	0	0	0	0	0	0	0	0	0	0
Bonnell Canyon - FS	0	0	3	2	0	0	0	0	0	0
Sauls Creek - FS	6	4	10	7	0	0	5	3	5	3
HD - FS	0	0	12	8	0	0	0	0	0	0
Mosca - FS	0	0	0	0	0	0	0	0	0	0
Freeman Creek - FS	0	0	0	0	0	0	0	0	0	0
Turkey - FS	3	2	4	2	0	0	2	1	2	1
Total	9	6	33	22	0	0	7	4	7	4

3.10.3.1.1 Alternative 1 — Proposed Action

Alternative 1 would impact 722 acres of National Forest land, 31 acres of BLM land and, over the Project Area, a total of 1,091acres as a result of CBM facility construction. CBM facilities on NFS and BLM lands would affect primarily undeveloped lands. The locations of the proposed CBM facilities within each land use category are shown on Figure 3–41. Within the Project Area, 183 acres of agricultural or rangeland and 791 acres of undeveloped land would be affected during construction (Table 3-117). Construction would also impact 106 acres of residential land and acreage in other areas within the Project Area.

Alternative 1 would affect primarily rangeland and undeveloped land (Table 3-114). Of the undeveloped land that would be affected, most consists of federal lands in the SJNF that are also used for livestock grazing and dispersed recreation.

Some agricultural and undeveloped lands would be removed from rangeland use for the life of the project because of displacement by dedicated CBM facilities. Under Alternative 1, less than one percent of the total rangeland in the Project Area would be affected.

Table 3-117 Summary of Impacts by Land Use Category, Surface Ownership, and Alternative

	Areal Extent of Disturbance by Surface Ownership									
	BLM		NFS		State		Private		Total[1]	
Land Use Category by Alternative	Construction (acres)	Operation (acres)	Construction (acres)	Operation (acres)	Construction (acres)	Operation (acres)	Construction (acres)	Operation (acres)	Construction (acres)	Operation (acres)
Alternative 1										
Agriculture/Rangeland	0.0	0.0	7.7	5.1	5.8	5.0	170.0	75.2	183	85
Undeveloped	25.2	17.0	712.1	464.1	15.7	11.5	38.4	25.5	791	514
Residential	3.0	2.0	0.1	0.1	0.0	0.0	103.5	59.1	106	61
Urban and Roads	3.0	2.0	2.4	1.6	0.0	0.0	5.2	3.5	10	7
Total	31.2	21.0	722.3	470.8	21.5	16.5	316.2	163.2	1,091	665
Alternative 2										
Agriculture /Rangeland	3.0	2.0	7.7	5.1	8.4	6.8	251.4	136.8	220	150
Undeveloped	49.2	33.0	1,135.4	744.3	34.0	23.8	132.4	88.8	1,484	930
Residential	6.0	4.0	0.1	0.1	0.0	0.0	158.0	106.6	164	110
Urban and Roads	3.0	2.0	2.4	1.6	0.0	0.0	5.2	3.5	10	7
Total	61.2	41.0	1,145.5	751.0	42.4	30.6	630.0	335.7	1878	1,197
Alternative 5										
Agriculture /Rangeland	0.0	0.0	0.0	0.0	5.8	5.0	115.2	78.7	121	83
Undeveloped	0.0	0.0	91.3	58.9	13.6	10.2	26.1	17.6	134	89
Residential	0.0	0.0	0.0	0.0	0.0	0.0	101.8	68.6	101	68
Urban and Roads	0.0	0.0	0.0	0.0	0.0	0.0	7.8	5.3	7	5
Total	0.0	0.0	91.3	58.9	19.4	15.2	251.0	170.2	447	275
Alternative 6										
Agriculture /Rangeland	0.00	0.00	7.7	5.1	5.80	5.00	110	75	123	85
Undeveloped	3.00	2.00	306.9	217.1	0.00	0.00	38	25	402	235
Residential	3.00	2.00	0.6	0.5	0.00	0.00	92	54	95	56
Urban and Roads	22.2	15.0	2.4	1.6	14.7	10.9	37	25	77	52
Total	28.2	19.0	317.5	224.1	20.5	15.9	277	179	697	428
Alternative 7										
Agriculture /Rangeland	0.00	0.00	7.7	5.07	5.80	5.00	110.0	75	123	85
Undeveloped	3.00	2.00	489.4	327.5	0.00	0.00	38	25	502	344
Residential	3.00	2.00	0.1	0.1	0.00	0.00	91	54	94	56
Urban and Roads	25.2	17.0	2.4	1.6	16.7	12.2	43.9	29	88	60
Total	31.2	21.0	499.6	334.2	22.5	17.2	283	183	807	545

Note:

1 Totals may not match precisely with values obtained by adding unit numbers because of rounding conventions, because some well locations are undetermined, and because some facilities are outside of the Project Area.

Approximately 17 wells would be constructed in farmland, removing the farmland acreage from production. Under Alternative 1, less than 1 percent of the total farmland in the Project Area would be affected. Impacts to prime farmlands are discussed in the Soils section of this chapter.

CBM construction in agricultural lands would damage or displace existing vegetation, such as crops or forage for livestock. Clearing the land would also increase the potential to introduce and spread weeds.

Dedicated CBM facilities located on agricultural lands would displace existing crops or rangeland during the operational and maintenance phases of the project. At least 30 years would lapse before the pre-existing agricultural land uses would be re-established after the project-related facilities are decommissioned and reclaimed.

Land use conflicts may occur at locations where CBM wells would be located on split-estate agricultural lands with private surface ownership and severed minerals. Eleven proposed CBM facilities would be located on split-estate agricultural lands (Table 3-115). All of the proposed well locations on private split-estate agricultural lands are within La Plata County.

The federal permitting process is designed to reduce the potential impacts to land uses for CBM development on lands with federal minerals. The BLM and FS would require surface use agreements, and the well locations would be negotiated with the landowners for development on properties with private surface ownership and federal minerals. Compensation for surface damages, and ROW, and access agreements would be negotiated with surface owners. Landowner agreements would be negotiated with the CBM developer on severed private mineral estate much the same way as is done for federal mineral estate. In such case, the county may be involved in on-site negotiations.

Rangeland impacts on National Forest and BLM lands would include reduced carrying capacity and overall disruption to and restriction of current livestock management and range. During the construction phase, clearing of vegetation and earth moving operations would damage or remove forage for livestock grazing. Surface disturbance may also introduce noxious weeds. The carrying capacity of some rangeland would be reduced. Both overgrazed and underused areas may result from changes to grazing patterns. If these patterns of use occurred, adjustments to grazing allotment management may be required.

The removal of native vegetation associated with the construction of the project facilities enhances opportunities for invasion and establishment of noxious weeds. The extent of these invasions is difficult to predict. However, noxious weed infestations could reduce the percentage of suitable forage species for livestock in the grazing allotments, resulting in AUM losses. The San Juan/San Miguel Planning Area RMP and amended RMP (BLM 1985, 1991), and the Decision Record for the Standards for Public Land Health and Guidelines for Livestock Grazing Management (BLM 1997) apply to development on BLM lands. Noxious weeds on NFS lands in the Project Area are managed under the San Juan/Rio Grande National Forest Weed Management Plan. CBM development would be subject to mitigation measures for weed control, minimizing the im-

pacts of noxious weeds on forage and rangeland in the Project Area. Noxious weeds are analyzed in the Vegetation section of this chapter.

Timbered ridges act as barrier to cattle movement in the grazing rotations. When access roads are constructed through these barriers, cattle use them as corridors into areas that are being deferred from grazing. It may be necessary to construct fences and install cattle guards in some of these access roads if cattle movement is persistent. In addition, existing range improvements, such as ponds, fences, and spring developments, would be protected.

An increase in the number of roads constructed in grazing areas and additional project-related traffic would increase the potential for disturbance or harassment of animals or collisions with livestock. New access roads or additional fencing that bisects fields may also fragment rangeland and limit movement of livestock.

The county-designated residential lands are classified into three categories: rural residential, existing subdivisions, and proposed subdivisions. Some proposed wells on all jurisdictions would be within or near existing or proposed subdivisions or rural residential lots in La Plata County (Figure 3–41). Land use conflicts have and will continue to occur where CBM facilities are located near private residential lands, such as subdivisions and rural residential properties. As shown in Table 3-115, four proposed CBM wells would be located on split-estate residential land under Alternative 1.

Conflicts would continue where CBM development on any of the jurisdictions encroaches on subdivisions and individual residences. The land use codes designed to reduce impacts from CBM development cannot fully mitigate these land use conflicts. These conflicts are particularly acute where surface landowners derive no monetary benefit from the well's production and incur possible property value loss caused by CBM development.

Intrusive effects to adjoining or nearby residential properties would occur from the sights and sounds of CBM-related activities on all jurisdictions. These effects may include increased fugitive dust, noise, and traffic delays on the roads; physical intrusion of the crew and equipment; and visual or aesthetic effects that could devalue residential properties. Some of these effects would occur during the construction and phase of CBM development and would be limited in duration because a well would be drilled within several weeks. Potential effects to residential property values are analyzed in the Social and Economic Values section of this chapter.

3.10.3.1.2 Alternative 2

Alternative 2 would impact 1,145 acres of National Forest land, 61 acres of BLM land, and over the Project Area a total of 1,878 acres during construction and installation of the proposed CBM facilities. CBM development on NFS and BLM lands would affect primarily undeveloped lands. The areal extent of this disturbance would represent 1.4 percent of the Project Area. This disturbance would involve 220 acres of agricultural or rangeland, 1,484 acres of undeveloped land, 164 acres of residential land, and acreage in other areas within the Project Area.

The areal extent of land uses displaced by CBM facilities would be greater than the other alternatives, affecting twice the residential land and undeveloped land than Alternative 1. The additional development would be concentrated within the 1½ mile near outcrop zone for the Fruitland formation and on grazing lands on the SJNF. Land use conflicts would increase when compared with Alternative 1.

3.10.3.1.3 Alternative 5 — No Action

Under Alternative 5, facility construction on National Forest and BLM lands would affect 91 acres (split estate) and zero acres, respectively. Undeveloped land would be the only land classification affected on National Forest. Total land area impacted over the Project Area would equal 447 acres of current land uses (Table 3-117). The areal extent of this disturbance would represent less than 1 percent of the Project Area. This disturbance would include 121 acres of agricultural or rangeland, 134 acres of undeveloped land, 101 acres of residential land, and acreage in other areas in the Project Area. Private and State land impacts would be as described for Alternative 1. The 91 acres of National Forest undeveloped land impacts are private mineral estate overlain by National Forest surface in the eastern portion of the Project Area (Figure 3–38).

3.10.3.1.4 Alternative 6

Alternative 6 would impact 317 acres of National Forest and 28 acres of BLM lands, both primarily classified as undeveloped. Over the Project Area, Alternative 6 would directly impact 697 acres. The aerial extent of this disturbance would represent less than 1.0 percent of the Project Area. This disturbance would involve 123 acres of agricultural or rangeland, 402 acres of undeveloped land, 95 acres of residential land, and acreage in other areas within the Project Area.

The aerial extent of land uses displaced by CBM facilities would be greater than Alternative 5 but less than Alternatives 1, 2, and 7. The development would be primarily in the west side of the Project Area and within the Sauls Creek, Spring Creek, and Fosset Gulch areas of the National Forest. The potential for land use conflicts would be approximately equal to Alternative 1.

3.10.3.1.5 Alternative 7

Alternative 7 would impact 500 acres of National Forest land, 31 acres of BLM land, and over the Project Area, a total of 807 acres as a result of CBM facility construction. The aerial extent of this disturbance would represent less than 1.0 percent of the Project Area. This disturbance would involve 123 acres of agricultural or rangeland, 502 acres of undeveloped land (mostly on National Forest), 94 acres of residential land, and acreage in other areas within the Project Area.

The aerial extent of land uses displaced by CBM facilities would be greater than Alternative 5 but less than Alternatives 1 and 2. The development would be primarily in the west side of the Project Area and on National Forest within the Sauls Creek, Spring Creek, and Fosset Gulch areas. The potential for land use conflicts would be approximately equal to Alternative 1.

3.10.3.2 Unroaded Lands within the Project Area

CBM development of existing mineral leases would affect the unroaded National Forest lands in the HD Mountains to varying degrees. The extent of impact varies by alternative. Table 3-118 summarizes the number of well pads and miles of road constructed within the unroaded area by alternative. Table 3-118 also presents the acres of unroaded land that would remain following implementation of each alternative.

Table 3-118 Impact to Unroaded Lands by Alternative

	Alternatives				
	1	2	5	6	7
Well pads	57	103	0	7	30
Roads (miles)	38	61	0	3	13
Unroaded Area Impacted by New Roads (acres)	12,385	22,799	0	2,500	4,480
Unroaded Area Remaining (acres)	15,411	4,997	27,796	25,300	23,320

3.10.3.2.1 Alternative 1 — Proposed Action

Fifty-seven well pads and 38 miles of road would be constructed in the unroaded portion of the HD Mountains, impacting approximately 44 percent of the existing unroaded area and leaving a residual area of 15,411 acres unroaded. The remaining unroaded area would form two smaller, non-contiguous blocks of 12,028 and 3,383 acres, respectively, within the core of the HD Mountains (Figure 3–42). The spine of the HD Mountains Inventoried Roadless Area would be developed from the terminus of FSR 756 in a north-south pattern that approximately follows the old stock driveway. Within the unroaded area, watersheds, wildlife and their habitat, recreation, vegetation and other resource values would be impacted by development. These resources are examined in detail in their respective sections of this Chapter.

The leaseholder proposes to develop nine wells on portions of lease COC–64935 (1,372 acres) issued within the HD Mountains Roadless Area in May 2001 with NSO stipulations. An APD has been filed for one well and an on-site review of the staked well location conducted. The APD will be acted on in the ROD for this project. Procedurally, NSO waiver determinations would be made at company request when APDs are submitted to develop the remaining proposed wells within the lease area. Surface occupancy on portions of the lease would be consistent with the lease terms, which allow waiver of the NSO stipulation if surface conditions permit surface occupancy without undue environmental impact. In 2005, the FS adopted a revised Roadless Area Conservation Rule. The new Rule directs that roadless area management will be in accordance with the management requirements contained in the national forest unit's current LRMP. The NSO stipulations that apply to lease COC–64935 therefore may be waived in whole or in part.

The leaseholder does not propose development of lease COC–64936 (998 acres) at this time. Lease COC–64936, within the HD Mountains Inventoried Roadless Area, was also issued in May 2001 with NSO stipulations.

3.10.3.2.2 Alternative 2

Alternative 2 would result in construction of 103 well pads and 61 miles of road in the unroaded portion of the HD Mountains. Alternative 2 would impact 22,799 acres of unroaded area, the largest impact among the alternatives. Three residual pockets of unroaded area would remain, totaling 4,997 acres (Figure 3–43).

Nine wells are proposed in the NSO lease area, COC–64935. The one surface location where an APD has been submitted would be acted on in the ROD for this project. NSO waiver requests for the other eight locations would be acted on when APDs are submitted.

Six wells would be developed within lease area COC–64936 in Alternative 2.

3.10.3.2.3 Alternative 5 — No Action

No wells or roads would be located in the unroaded area at this time (Figure 3–44). Therefore, 27,796 acres would remain unroaded.

3.10.3.2.4 Alternative 6

A total of seven wells and three miles of road would be constructed in the unroaded portion of the HD Mountains. No wells or roads would be located in the core HD Mountains Inventoried Roadless Area. Development would be concentrated mostly on the east flank of the unroaded area (Figure 3–45) The residual unroaded area would total 25,300 acres, second largest among the five alternatives, and approximately 20 percent larger than the HD Mountains inventoried roadless area delineated during the 1979 RARE II process. The unroaded area would remain one single contiguous block of land.

Lease areas COC–64935 or COC–64936 would not be developed under Alternative 6.

3.10.3.2.5 Alternative 7

Alternative 7 would result in construction of 30 well pads and 13 miles of road in the unroaded portion of the HD Mountains (Figure 3–46). Impacts would be similar to Alternative 6 in terms of location and extent of development. The residual unroaded area would total 23,000 acres, third largest among the alternatives and approximately 10-percent larger than the HD Mountains Inventoried Roadless area in size. Development would be concentrated mostly on the east flank of the unroaded area and along the stock driveway south of FSR–756 to the rock bridge (Figure 3–46) Within potions of the unroaded area, watersheds, wildlife and their habitat, recreation, vegetation and other resource values would be impacted by gas development. These resources and uses are examined in detail in their respective sections of this Chapter.

Three wells and associated access roads would be developed in lease area COC–64935. There would be no development in lease area COC–64936.

3.10.3.3 Ignacio Creek and Archuleta Mesas — Potential Research Natural Areas

Alternatives 1and 2 would result in development of 36 wells and associated roads from 24 well pads in the potential Ignacio Creek RNA. Alternatives 5, 6, and 7 would not involve surface development within Ignacio Creek and thus would not impact the potential RNA at this time. The impacts associated with developing the Ignacio Creek area are analyzed in the surface water, geology, recreation, and wildlife sections of this Chapter.

The leaseholder proposes to develop seven wells and one compressor in the Archuleta Mesas area, lease COC–64932 (Alternative 1). Alternatives 2, 6, and 7 involve the same development scenario as Alternative 1. Alternative 5 prescribes no development of federal leases; thus, there would be no surface development of the lease that overlays the Archuleta Mesas potential RNA at this time.

The NSO stipulation that now applies to the leases in the Archuleta Mesas would be acted on as notices of staking or applications for permit to drill are received.

3.10.4 Cumulative Effects

Cumulative land use effects are defined as the sum of the past, present, and reasonably foreseeable actions that may affect land use patterns within La Plata and Archuleta Counties. The cumulative effects analysis includes the sum of the long-term oil and gas development impact within the portion of the NSJB in La Plata and Archuleta Counties. The areal extent of land displaced by existing and proposed oil and gas development within the Project Area for each land use category is shown in Table 3-119.

Table 3-119 Cumulative Displacement of Land for Oil and Gas Facilities, by Land Use Category and Alternative

Land Use Category	Existing Oil and Gas Facilities in Project Area (acres)	SUIT FEIS Preferred Alternative[1] (acres)	Cumulative Land Displacement for Oil and Gas Facilities by Alternative[2] (acres) 1	2	5	6	7
Agriculture/Rangeland[3]	267	1,082	1,424	1,500	1,432	1,434	1434
Undeveloped	204	1,310	2,028	2,445	1,63	1,749	1,858
Residential	80	68	209	258	216	204	204
Urban and Roads	2	10	19	19	17	19	19
Total[4]	553	2,470	3,680	4,222	3,268	3,406	3,515

Notes:
1. Most of the land displacement associated with the SUIT FEIS Preferred Alternative is within La Plata County.
2. Cumulative is the sum of long-term land displacement for existing oil and gas facilities, SUIT FEIS Preferred Alternative, and the proposed CBM facilities for each alternative.
3. The agriculture/rangeland category includes farmland.
4. Totals may not match precisely with values obtained by adding unit numbers because of rounding conventions.

Under Alternative 1, the cumulative effects of CBM development within La Plata and Archuleta Counties, including the SUIT Reservation, would include total displacement of existing land uses from 3,680 acres for CBM facilities for the life of the project. Land use conflicts between CBM development and residential growth would be amplified over the cumulative effects area. However, large-scale changes to growth patterns are not likely to result from the proposed CBM development. In La Plata County, an increase in residential construction and urban growth is expected to occur along with an increase in the number of gas wells (La Plata County 2002b). Archuleta County would experience a similar response to CBM development.

Under the action alternatives there should be little adverse impact to the forage resource in the future. Re-seeded disturbed areas could actually produce more forage than before disturbance. Livestock distribution could actually improve due to better access using reclaimed roads. Should this occur, there could be less overall grazing pressure on key areas such as riparian bottoms. Therefore, forage conditions on key areas should continue to meet or exceed standards contained in land management plans.

With or without additional CBM development, the current trends in development in La Plata County suggest that future urban growth would be primarily concentrated in the areas southeast of the City of Durango near the intersection of U.S. Highway 550 and U.S. Highway 160 and around the Town of Bayfield. CBM development should not alter this growth pattern. Currently, no major industrial projects, such as power plants or manufacturing facilities, are planned in La Plata County (BLM et al. 2002). The current trends in development for Archuleta County indicate no future urban areas within the Project Area.

3.10.5 Mitigation and Monitoring

BLM is responsible for issuing and managing leases that involve federal minerals and for specifying mitigation measures to protect surface resources as part of the APD approval process. The FS has similar responsibilities for development on NFS lands as part of the authorization of surface use plans. Unless otherwise stated, the following measures would be funded by the companies.

The companies would develop reclamation and revegetation plans for all federal land areas impacted by CBM-related facilities. Through the APD process, the specific locations of the new CBM facilities would be selected to avoid or minimize conflicts with nearby existing land uses. For split-estate lands, CBM facilities would be sited with input from the landowner and surface use agreements would be developed with the landowner, including negotiated compensation for loss or compromise of land use.

The mitigation measures currently required, such as noise ordinances, setbacks, and participation in visual mitigation, would reduce, but not eliminate, potential impacts to land use. No additional mitigation measures were identified.

3.10.5.1 Rangeland Management Mitigation Measures

- Construct fences and install cattle guards as necessary to manage livestock movement if natural barriers are impacted by project facilities.
- Protect existing range improvements, such as ponds, fences, and spring developments. The companies would be responsible for repairing and/or replacing any improvements damaged by project implementation.
- Protect or avoid all permanent monitoring stations. These include, but are not limited to locations of Parker 3-step transects, rooted nested frequency transects, grazing exclosures, and browse transects.

3.10.6 Conformance with Existing Plans and Policies

The land use plans and policies that apply to CBM development vary depending on surface and mineral ownership of the properties where CBM facilities would be installed.

CBM-related surface disturbances that affect federal land are under the jurisdiction of either BLM or FS. BLM and FS management plans for federal lands in the Project Area support mineral development, including oil and gas. Oil and gas development on federal lands must conform to the applicable lease stipulations, best management practices, and additional mitigation measures where required. The guidance documents and policies for CBM development on federal lands in the Project Area include:

- The San Juan and San Miguel RMP and EIS and amended RMP (BLM 1984a, 1984b, 1991),
- The Colorado Oil and Gas Leasing and Development FEIS (BLM 1991),
- The SJNF LRMP (FS 1983) and the amended LRMP (FS 1992),
- The 1997 Public Land Health Standards for BLM lands in Colorado.
- The Interim Criteria for Fruitland CBM Development set forth in NTL No. CO-SJFO-2001-01 (BLM 2000c),
- The current spacing orders, which allow two wells per 320 acres in La Plata County (COGCC 2000a) and one well per 320 acres in Archuleta County (COGCC 1990).

A site-specific NEPA analysis is completed when an application for permit to drill, BLM right-of-way grant, or FS special use permit are filed with the BLM and FS. At that point, a specific well or group of wells is assessed in detail, and mitigation measures are attached as COAs to the individual permit. The COA must reflect the lease rights granted, applicable federal environmental protection laws, and the management requirements of the 1984 RMP, 1991 amended RMP and Colorado EIS, and the 1983 LRMP and 1992 amended LRMP.

La Plata County has developed several regional land use plans within the Project Area. These plans include maps that define the future goals for land use for each planning area. The plans are advisory documents for the County and are not regulations. Most of the proposed CBM wells in La Plata County would be located

where the future land use designation is agricultural. CBM facilities are generally considered compatible with agricultural land use (La Plata County 2002b, BLM et al. 2002).

Two CBM facilities are proposed on private property in Archuleta County and would be subject to State and County regulation. All of the other proposed CBM facilities to be located in Archuleta County would be on federal undeveloped land in the SJNF. The County land use regulations would not apply for proposed CBM facilities located on federal properties because the County has no jurisdiction over development on federal lands.

3.10.6.1 Alternative 1 — Proposed Action

With respect to general land uses, which are a broad category of multiple use zones used on federal lands, Alternative 1 would conform to the current management plans for federal lands in the Project Area. With respect to the rules, orders, and requirements that pertain to energy mineral development, Alternative 1 would conform to current spacing orders in La Plata County on private, State, and federal jurisdictions. In May 2000, the BLM issued a decision and order that allowed for infill development of CBM wells on federal lands in the NSJB. All of the windows and locations that make up this alternative are consistent with the Interim Criteria for Fruitland and CBM Development set forth in NTL No. CO–SJFO–2001–01 (BLM 2000c).

The current rule (COGCC 112–85) permits one well per 320-acre spacing unit, whereas Alternative 1 presents industry's proposal to develop these leases at two wells per 320 acres. Full implementation of Alternative 1 in Archuleta County would require a change in the current well spacing rule for the Fruitland Formation to two wells per 320-acre unit or unitization of the leaseholds into a participating unit agreement. Establishment of well field spacing rules falls within the authority of the COGCC on private and state land and within the authority of the BLM on federal mineral estate. One company has established a federal participating unit and another unit application is pending. Spacing rules do not apply to the Federal units, so the proposed four wells per section that would be developed on federal lands within Archuleta County are consistent with the regulations that apply to federal units.

Surface development of two leases, COC–64935 and COC–64936, would require waiver, or modification of the current NSO stipulation. Surface development of the leases would be consistent with the 2005 Roadless Area Conservation Rule, the current SJNF LRMP, and stipulations placed on the two leases.

Alternative 1 is consistent with the Interim Criteria for Fruitland CBM Development set forth in NTL No. CO–SJFO–2001–01 (BLM 2000c). These criteria specify no well development on federal jurisdiction within 1.5 miles of the outcrop to the Fruitland Formation pending completion of this EIS. This EIS then becomes the basis for approval of further development within the near-outcrop zone. It is not inconsistent with the Interim Criteria for industry to propose development and for the BLM to approve development within this zone.

CBM development on private or state leases would conform to both COGCC requirements and the existing local land use policies.

3.10.6.2 Alternative 2

Alternative 2 would conform to the current management plans for federal lands in the Project Area. There is no inconsistency with the multiple-use goals established for the BLM and NFS lands defined in the federal land and resource management plans.

Alternative 2 is consistent with the Interim Criteria for Fruitland CBM Development set forth in NTL No. CO–SJFO–2001–01 (BLM 2000c). It is also consistent with the COGCC criteria for CBM development in the near-outcrop zone (COGCC 2000a). The COGCC requires specific procedures for hearing and review for approval of wells within 1.5 miles of the outcrop zone on private and state lands.

CBM development on private or state leases would conform to both COGCC requirements and the existing local land use policies.

3.10.6.3 Alternative 5 — No Action

Alternative 5 is inconsistent with the multiple use goals as defined in the federal land and resource management plans for management of federal lands within the Project Area. These goals provide for energy mineral development within the Project Area.

Alternative 5 is not consistent with the rights conveyed by existing leases on federal lands. Federal land use goals include mineral development on federal lands with existing leases, subject to compliance with the terms of the lease and with applicable laws, regulations, and policy.

CBM development on private or state leases would conform to both COGCC requirements and the existing local land use policies

3.10.6.4 Alternative 6

In general, Alternative 6 would conform to the current management plans for federal lands in the Project Area. There is no inconsistency with the multiple-use goals established for BLM and NFS lands as defined in the federal land and resource management plans.

From the standpoint of energy development in the HD Mountains, this alternative is not consistent with the lease rights granted in the Inventoried Roadless Area. Alternative 6 does not permit development of existing leases that would otherwise qualify for development after review of environmental consequences and compliance with law and regulation.

CBM development of private or state leases would conform to both COGCC requirements and the existing local land use policies.

3.10.6.5 Alternative 7

Alternative 7 would conform to the current management plans for federal lands in the Project Area. Alternative 7 would conform to current spacing orders in La Plata County on private, state, and federal jurisdictions. Implementation of Alternative 7 in Archuleta County would require a change in the current well spacing rule for the Fruitland Formation to two wells per 320-acre unit or establishment of federal units where proposed spacing is inconsistent with current well spacing. One participating federal unit has been approved and another is pending approval.

Surface development of lease COC–64935 would require waiver or modification of the current NSO stipulation and would otherwise be consistent with the 2005 Roadless Area Conservation Rule, the current SJNF LRMP, and with the stipulations contained in the lease.

Alternative 7 is consistent with the Interim Criteria for Fruitland Formation CBM Development set forth in NTL No. CO–SJFO–2001–01 (BLM 2000c). These criteria conditionally restrict well development on federal jurisdiction within 1.5 miles of the Fruitland Formation outcrop pending completion of this EIS. This EIS is the basis for evaluation of further development within the near-outcrop zone. It is not inconsistent with the Interim Criteria for industry to propose and for the BLM to approve development within the Fruitland Formation outcrop zone.

CBM development on private or state leases would conform to both COGCC requirements and the existing local land use policies.

3.10.7 Unavoidable Adverse Effects

Unavoidable adverse effects would include displacement of existing agricultural, rangeland, and undeveloped federal lands for CBM well facilities for the life of the project. In addition, CBM-related activities may result in intrusive effects to nearby residential properties. These effects may include increased dust, noise, visual, or aesthetic effects, and traffic delays on the roads. These effects would occur primarily during the construction phase of CBM development.

3.10.8 Irreversible and Irretrievable Effects

Pre-existing land uses would be re-established after site reclamation is complete. However, some access roads constructed for energy mineral development may be retained as part of the permanent FS road system after project completion. Retaining these roads would represent a long-term conversion of the pre-project resources to road use. This action is irretrievable, but is not irreversible.

3.11 Recreation

3.11.1 Issues

Issue 14 Effect of additional CBM development on recreational opportunities.

Facets of this issue include the following:

- Will CBM development affect recreational opportunities and amenities, particularly near towns and residential areas?
- Will new roads provide additional access for vehicles and promote an increase in human activity, particularly on NFS land and areas that are currently roadless?
- How will increased human activity affect wildlife-related recreation (viewing wildlife, hunting wildlife, and fishing)?

3.11.2 Affected Environment

3.11.2.1 Recreation Use and Management

Land in La Plata and Archuleta Counties offers diverse recreational opportunities, including but not limited to camping, backpacking, hiking, mountain biking, fishing, sightseeing, landscape photography, hunting, picnicking, whitewater rafting, horseback riding, ATV riding, other motorized vehicle uses, and winter sports. Trail-related recreation is in high demand in La Plata County and generates substantial tourism. The Project Area includes existing or planned developed trail systems, as well as recreation on unmaintained casual dispersed trails on federal land (Figure 3–47).

3.11.2.1.1 Developed Recreation

Developed recreation in the Project Area is limited to privately owned or city-managed facilities in or near Durango and Bayfield. There are no developed facilities on NFS or BLM land in the Project Area, nor are there any county-owned or operated facilities in the Project Area.

The Durango East KOA campground along U.S. Highway 160 in the western side of the Project Area operates between April 15 and October 15. The Cottonwood Camper Park is located on Highway 160 between Bayfield and Durango. The Riverside Recreational Vehicle (RV) Park is on Highway 160 northeast of Bayfield. There are no other developed recreation sites in the Project Area, but there are numerous opportunities for developed recreation in La Plata and Archuleta Counties outside the Project Area. County roads that cross through the Project Area provide access to recreation sites at Vallecito Reservoir and Lemon Reservoir, both 5 miles to the north, and to Navajo Reservoir to the southeast.

The proposed Cedar Hills Golf Course and residential subdivision is on 703 acres between County Road 223 and Highway 160, about 12 miles east of Durango. This subdivision would be on land that is currently part of the Wildorado Ranch in the heart of the Project Area. It is in an area of existing oil and gas exploration

and production where additional development of CBM is planned. In addition, a regional park may be developed in the Grandview area.

3.11.2.1.2 Dispersed Recreation

A broad spectrum of dispersed recreation occurs year-round in La Plata and Archuleta Counties mostly on National Forest and BLM lands. Summer activities include hiking, mountain biking, hunting, fishing, camping, sightseeing, ATV riding, landscape photography, and wildlife viewing. Dispersed winter activities include cross-country skiing, snowmobiling, and snowshoeing. Numerous 4-wheel-drive roads and unmaintained trails traverse the Project Area and offer opportunities for dispersed activities. Outfitters and guides provide for some dispersed uses (hunting) as well as trail uses (mountain biking and horseback riding).

Bicycle commuters, recreational bicyclists, and competitive bicyclists training for races use Highways 160 and 500 and the La Plata County Road system. The La Plata County Comprehensive Traffic Study has defined the network of bicycle routes within the Project Area, described in Table 3-120. County Roads 234 and 501 and U.S. 160 access several existing CBM wells.

Table 3-120 Bicycle Routes in the Northern San Juan Basin Project Area

Road Name	From	To	Bicycle Route Name
CR 234	Intersection of CR 240	Intersection of U.S. 160	Durango Loop
CR 501	Intersection of CR 240	Intersection of U.S. 160	Helen's Store/Bayfield/ Ignacio Loop
U.S. 160	Durango City Limit	La Plata County East County Line	U.S. 160 East from Durango to county line
U.S. 550	Intersection of CR 220	Durango City Limit	Durango Loop/Helen's Store/Bayfield/Ignacio Loop

Source: La Plata County Planning Department 1999

Motorized recreational uses, including 4-wheel-drive vehicles, are available throughout most National Forest land in the Project Area. OHVs are restricted to between June 1 and November 2 on National Forest land, eliminating snowmobile use. BLM land is open to OHVs, but these uses are limited on BLM parcels in the Project Area because they are small and isolated and are not suitable for OHVs, with the exception of the Grandview area.

3.11.2.1.3 Trails

The Grandview Ridge Trail System is southeast of Durango on BLM and private land in the western portion of the Project Area. The intersecting trails are used heavily by mountain bikers, as well as by hikers, horseback riders, and hunters. The trails are not accessible to motorized vehicles.

These trails are the southern portion of a more extensive system that is easily accessible from Durango and is a popular recreation area with local residents and tourists. Trails on Grandview Ridge in the Project Area include Carbon Junction, Crites Connect, Telegraph, Sidewinder, Skull Rock Loop, Grandview Rim Trail, Sale Barn, Grandview Ridge Trail, Old Car Loop, and Cowboy Trail. These are

primarily on BLM land. The outcrop of the Fruitland Formation is along the northern boundary of the trail system. Eight existing wells that are visible or audible to recreationists are situated near trails.

The FS is preparing a study for a motorized and nonmotorized trail system along Sauls Creek, northeast of Bayfield, near the La Plata/Archuleta County line. The Forest Service proposes that existing informal trails be linked and that signs and a parking lot be added to the proposed trail system. After the system is in place, it will be suitable for races and other special events. Five CBM wells are near existing trails in the Sauls Creek area.

3.11.2.1.4 Hunting and Fishing

Hunting is a major recreational use of federal land in the Project Area. Big-game hunting seasons occur between late August and mid-January. Elk, deer, bear, mountain lion, and game birds are found in suitable habitats throughout the Project Area. Big game is managed by CDOW in game units. The Project Area contains portions of four game units.

A limited amount of fishing occurs on streams in the Project Area. Most fishing on the Piedra, Florida, and the Pine Rivers is in upstream reaches north of the Project Area. Existing CBM wells can affect recreational opportunities by disturbing wildlife and by converting wildlife habitats to well pads and access roads. In addition, hunters and fishermen, as well as other recreational visitors, encounter the sight and sound of CBM wells in some areas, including NFS land. Table 3-121 summarizes the number of participating hunters and recreation days for each game unit.

Table 3-121 Hunting in the Northern San Juan Basin Project Area

Game Unit	Total Hunters		Change 1999-2000 (percent)	Total Harvest		Percent Success		Total Recreation Days		Change 1999-2000 (percent)
Year	1999	2000		1999	2000	1999	2000	1999	2000	
Deer										
75	947	835	-12	378	396	40	47	4,032	3,572	-11
77	912	1,045	15	324	455	36	44	3,695	4,444	20
751	1,247	1,341	8	301	279	24	21	5,570	6,921	24
771	706	719	2	345	398	49	55	2,752	2,437	-11
Total	3,812	3,940	3	1348	1528	35	39	16,049	17,374	8
Elk										
75	3,270	3,124	-5	513	994	16	32	17,100	14,081	-17
77	2,044	2,371	16	225	617	11	26	10,981	11,055	1
751	4,234	3,760	-11	430	1,073	10	29	23,311	18,108	-22
771	1,157	1,152	-0	137	375	12	33	6,996	5,674	-19
Total	10,705	10,407	-3	1305	3,059	12	29	58,388	48,918	-16

Source: CDOW 2001

3.11.2.2 San Juan National Forest and BLM Recreation Management

The SJNF offers a wide variety of year-round dispersed recreational opportunities in the eastern part of the Project Area. Such activities account for the largest amount of recreational uses and are projected to be the fastest-growing segment of recreation use on the SJNF. There are no developed recreation sites on the SJNF in the Project Area.

Recreational use of most BLM land in the Project Area is limited, as it consists of isolated tracts surrounded by private property and generally is not accessible by road or trail, with the exception of Grandview Ridge.

Based on the variations in types of use of the recreation areas in the Project Area, the Area has been divided into six distinct and separate areas (Figure 3–48), as follows:

1. Grandview Ridge (BLM)
2. BLM Dispersed Tracts
3. Sauls Creek (NF)
4. Spring Creek (NF)
5. HD Mountains (Roadless Area - NF)
6. Fosset Gulch (NF)

Grandview Ridge: The BLM Grandview Ridge Coordinated Resource Management Plan (CRMP) addresses increasing demands for recreation and the potential conflicts among recreation, wildlife, and mineral development. The Grandview CRMP amends the existing San Juan Field Office RMP by adding a nonmotorized-recreation emphasis to the Grandview Ridge Area, which is roughly 1,600 acres.

Nonmotorized access to Grandview Ridge is available at Big Canyon and Sale Barn Canyon, directly off U.S. Highway 160. The primary access is via Horse Gulch north of the Project Area in Durango. The Horse Gulch Area trail system is north of Grandview Ridge and connects with the Grandview Ridge trail system. The area contains 26.4 miles of the trail system. The Southern Ute Indian Tribe has acquired 900 acres directly east of the Grandview Ridge area and plans a commercial/residential development of more than 2,500 homes and businesses that would increase the recreational demands in the area. Travel management within the area is restricted to nonmotorized use, except for access for mineral development.

BLM Dispersed Tracts: A number of BLM dispersed land tracts are located throughout the Project Area. A broad spectrum of dispersed recreation occurs, such as hiking, mountain biking, hunting, ATV riding, and wildlife viewing. Dispersed winter activities include cross-country skiing, snowmobiling, and snowshoeing. Numerous 4-wheel-drive roads and trails traverse the Project Area and provide opportunities for dispersed activities. Outfitters and guides engage in some dispersed uses (hunting) as well as trail uses (horseback riding). No legal

access is available to the public for many of these tracts, which are open to motorized use.

Sauls Creek: The Sauls Creek Area is east of Bayfield and is about 3,800 acres. It is an important recreation area for the community of Bayfield and receives extensive motorized and nonmotorized use. There are 9 miles of designated system trails that are used year-round by recreationists. The area is also used heavily in the fall for big-game hunting and is accessed from Forest Roads 608, 755, and 743. The area is open to motorized use between June 1 and November 30.

Spring Creek: This area, southeast of Bayfield, is some 6,000 acres. Local residents use Spring Creek for both motorized and nonmotorized recreation. ATV use is extensive next to the residential areas. The area is also heavily used in the fall for hunting, and is open to motorized use between June 1 and November 30.

HD Mountains Roadless Area: The Roadless Area forms the backbone of the HD Mountains. There is one road corridor, Forest Development Road (FDR) 756, which cuts up the middle of and to the top of the Roadless Area and provides access to a shut-in well and the Piedra Stock Driveway. The Roadless Area is 9 miles long and is reached by foot or horseback from the south or north, or by hikers dispersing from FDR 756 from the top.

The HD Mountains provide opportunities for a variety of dispersed recreational activities, primarily hunting, ATV and 4-wheel-drive use, camping, and sightseeing. Seasonal big-game hunting is the major attraction. There is a limited amount of cross-country skiing and Christmas tree cutting. There are no established trails or developed recreation sites within the HD Mountains; ATVs and other 4-wheel-drive vehicles have carved numerous tracks through parts of the area. Portions of the HD Mountains offer opportunities for backcountry recreation, particularly hikes along the stock driveway at the top of the HDs and along the riparian area that drains the Ignacio Creek area. Ignacio Creek can be accessed from the north or south but requires a Southern Ute road permit to access the area from the south. There are two CBM wells in the HD Mountains Roadless Area.

Fosset Gulch: The Fosset Gulch area is east of the HD Mountains and parallels U.S. Highway 160. The area is about 7,500 acres and is reached by the Fosset Gulch Road (FDR 613). The area receives limited recreational use. It is open to motorized use from June 1 to November 30. Hunters access and use the area on foot, horseback, and ATV. The existing road system, which is a remnant of past timber sales on the eastern flank of the HDs, provides easy access to portions of the Pargin Mountain area. The general setting is natural looking, but with a low to moderate amount of road access. Past timber harvest is evident, and recreationists accessing the area from the south must pass by existing wells. Hunters continue to return to the area annually, attracted by the quality of the hunting experience.

3.11.2.3 County Recreation Management

The La Plata County Comprehensive Plan, completed in 2001, is intended to incorporate and uphold the intent of the district plans and to give additional detail and guidance to the overall growth management system of La Plata County. The

Parks, Recreation, and Trails element of the County Comprehensive Plan focuses on recreational programs and facility needs. Recreational facilities in the unincorporated county are limited, although the demand is increasing as the population in unincorporated areas of the county has grown. Accordingly, the primary goal of the Comprehensive Plan (Goal 11.1) is to ensure that the needs of residents for recreational programs and facilities are met as the County grows.

The Archuleta County Community Plan, adopted by the Planning Commission in March 2001, includes policies to maintain the necessary level of public facilities and services, including recreation, to serve the population adequately. Most of Archuleta County within the Project Area is federal land administered by the SJNF. There is one existing CBM well on private land within the Project Area in Archuleta County.

The La Plata County Open Space Conservancy, a private, nonprofit land trust, has been granted parcels of private land north and east of Bayfield as La Plata County Open Space Conservancy Protected Properties. Agricultural landowners donated the land for wildlife conservation easements in return for inheritance and other tax benefits. The open-space properties retain wildlife habitats and the natural setting and enhance the overall rural ambience of the Project Area. The open-space properties act as visual buffers around and between developments, and protect view corridors along county roads and state highways. Two CBM wells are operating in open-space parcels.

3.11.3 Environmental Consequences

3.11.3.1 Recreation Impacts

Recreational impacts would occur over the life of the proposed CBM development. Specifically, recreation impacts would include:

- CBM development altering the natural setting or character of an area used for recreation;
- CBM-related construction, operation, and maintenance disrupting recreation as a result of noise, dust, traffic, and increased human activity;
- CBM development increasing vehicle access into previously roadless or inaccessible areas; and
- CBM development that may not be compatible with federal, state, or county objectives for recreation in the Project Area.

3.11.3.1.1 Alternative 1 — Proposed Action

Recreational Use/General

The landscape in the Project Area ranges from rural on private land in La Plata County to predominantly natural-appearing, undeveloped on NFS land in the Project Area's eastern half. Oil and gas operations have added an industrial component to the landscape, primarily on federal, state, and private land in La Plata County. Additional wells add to this industrial component of the landscape and introduce new sources of vehicle traffic and noise that would diminish the recreational setting sought by recreationists. The gas well access roads would be gated and closed to public motorized use.

Local residents value the federal lands for recreation because the lands are mostly undeveloped and provide solitude that can be achieved within a short distance from home. The solitude now experienced on public land would be most impaired by CBM development during the 5-year construction period. Recreationists would encounter wells and roads where there had been for the most part, natural-appearing landscapes.

Access to the SJNF would be altered by development of an extensive road system. The opportunity to recreate in an undeveloped landscape would be lost over portions of the Project Area and the impact would continue over the life of the project. The views from designated trail systems and informal trails used by mountain bikers, hikers, horse riders, OHV users, hikers, cross-country skiers, photographers, and wildlife viewers would be altered by well pads and roads. Recreationists would experience minor conflict with increased traffic from project vehicles and more noise and airborne dust than they encounter now.

Developed Recreation

There are three privately owned campgrounds in the Project Area: the Cottonwood Camper Park, the Durango East KOA campground, and the Riverside RV Park. Well windows are adjacent to all three campgrounds. The sights and sounds of the increased well construction traffic and drilling during the construction period could distract campground visitors. After well installation is completed, project-related trips for operations and maintenance would not result in a noticeable increase in traffic on the highway.

The campgrounds would be visually impacted by the gas facilities and well facilities may be audible. One well window is located in the proposed Cedar Hill golf course and subdivision. For golfers and residents, construction and operation of a well and ancillary facilities would present an audible and visual intrusion. The golf course and subdivision have not yet been constructed, however, and the CBM well would precede construction.

The visual and audible intrusion of construction and the operation of CBM facilities over the life of wells would reduce the quality of recreational setting for users of the Grandview Ridge and Sauls Creek trail systems. The Grandview Ridge trails are southeast of Durango on BLM and private land in the western portion of the Project Area. The Sauls Creek trail system is northeast of Bayfield, near the La Plata/Archuleta County line. There is one well window within the Grandview Ridge Trail System. There are four well windows on private land and eight known well locations on NFS land proposed for the vicinity of the Sauls Creek trail system.

Dispersed Recreation

There may be a reduction in the number of hikers, campers, and mountain bikers who would normally be attracted to backcountry settings of the National Forest in the HD Mountains. The absolute number of hunters may not be reduced appreciably; however, because the expanded road system would increase foot and horseback access and possibly attract additional use to the area.

Fishing is a minor use of streams in the Project Area; most fishing is in the upper reaches of streams north of the Project Area. Thus, there would be minimal impacts on fishing from project construction and operations.

Impacts on BLM/FS Recreational Areas and Travel Management by Proposed CBM Construction and Operation

Proposed CBM development would require road construction in some areas that were not previously accessible by road. The BLM and FS currently allow off-road, cross-country travel by motorized vehicles. The existing FS road system and travel management are shown on Figure 3–49. The new roads would increase access and would result in additional wildlife and resource impacts on public lands.

The travel management restrictions that apply to Alternatives 1, 2 6, and 7, which are mitigation measures for soils (Section 3.7), vegetation (Section 3.8), and wildlife (Section 3.9) would limit motorized use to designated roads and trails on NFS lands. These restrictions would change the designation of the FS travel management area from “C” to “A.” Thus, all motorized travel would be prohibited yearlong, except on designated roads and trails which would be open with seasonal restrictions. The majority of gas well access roads would be gated and closed to motorized travel yearlong. The gas companies would be allowed to use access roads as necessary to maintain the facilities, in compliance with seasonal restrictions and resource mitigation measures. No change in travel management is proposed for BLM land at this time.

This change in travel management, as well as the potential impacts to recreation areas within the Project Area, is reflected in the discussion of environmental-consequences of the alternatives that follows. The proposed FS road system and travel management policy are shown in Figure 3–50. Table 3-122 describes impacts to the six recreation areas by alternative.

Grandview Ridge: Motorized recreation use would continue to be prohibited in the Grandview Ridge area. There would be no wells or associated access roads in the area. Therefore, there would be no effect on recreational use of the area from construction and operation of CBM facilities.

BLM/FS Dispersed Tracts: Eighty-eight facilities would be developed on dispersed tracts. Motorized travel would be managed as described above. Most of the BLM dispersed public land is already developed for oil and gas. Recreationists would continue to use these dispersed tracts in the same numbers because they are accustomed to this developed landscape partially dominated by gas facilities.

Sauls Creek: Motorized use would be restricted to designated roads and trails as described above. Thirty-four facilities would be developed. With the exception of designated recreation routes, the gas well access roads would be gated and closed to public motorized use. Users of the Sauls Creek trail system would experience a change in the quality of the recreational setting due to the audible intrusion of construction and operation of CBM facilities near the trail system. Recreationists would continue to use the area in moderately high numbers because of proximity to Bayfield.

Table 3-122 Proposed CBM Facilities in National Forest and BLM Recreation Areas

Alternative/Recreation Area	Number of Facilities[1]	Long Term Facility Disturbance (acres)	Roads (miles)	Long Term Road Disturbance (acres)
Alternative 1				
Grandview Ridge (BLM)	0	0	0	0
BLM/FS Dispersed Tracts	88	91	18	56
Sauls Creek	34	38	10	30
Spring Creek	27	32	10	30
HD Mountains	58	67	38	115
Fosset Gulch	65	80	42	126
Total[2]	278	308	118	357
Alternative 2				
Grandview Ridge (BLM)	13	13	4	11
BLM/FS Dispersed Tracts	177	180	44	133
Sauls Creek	49	53	16	50
Spring Creek	58	65	25	75
HD Mountains	104	113	61	182
Fosset Gulch	109	117	54	163
Total[2]	509	543	202	614
Alternative 5				
Grandview Ridge (BLM)	0	0	0	0
BLM/FS Dispersed Tracts	78	84	18	63
Sauls Creek	18	20	4	13
Spring Creek	7	7	2	5
HD Mountains	0	0	0	0
Fosset Gulch	17	17	15	49
Total[2]	122	131	39	130
Alternative 6				
Grandview Ridge (BLM)	0	0	0	0
Dispersed Tracts	88	91	18	56
Sauls Creek	34	38	10	30
Spring Creek	27	32	10	30
HD Mountains	0	0	0	0
Fosset Gulch	36	42	24	88
Total[2]	188	230	65	204
Alternative 7				
Grandview Ridge (BLM)	0	0	0	0
Dispersed Tracts	88	91	18	56
Sauls Creek	34	38	10	30
Spring Creek	27	32	10	30
HD Mountains	26	34	14	51
Fosset Gulch	65	80	42	112
Total[2]	239	297	92	279

Note:
1. The facilities include well pads, water disposal wells, compressors, and gathering stations.
2. Totals for numbers of facilities in Recreation differ from Chapter 2 numbers because they do not include disposal wells and compressors located outside of the Project Area that are part of the alternative actions (see Tables 2–1, 2–6, 2–7, 2–8 2–13, 2–17, and 2–18).

Spring Creek: Motorized travel would be limited to designated roads and trails as described above. Twenty-seven facilities would be developed within the Spring Creek area. With the exception of certain designated routes, access roads to the gas wells would be gated and closed to public motorized use. The same types of recreation impacts expected for Sauls Creek would also apply to Spring Creek because of proximity to population centers. Many recreationists would react negatively to the increased development and density of wells, but would continue to use the area as they traditionally have because of proximity to Bayfield.

HD Mountains Roadless Area: Motorized travel would be restricted to designated roads and trails to reduce soil, vegetation, and wildlife impacts. Fifty-seven facilities are proposed for NFS land within the HD Mountains Inventoried Roadless Area. Gas wells access roads would be gated and closed to public motorized use. The proposed facilities would modify the landscape, introducing an industrial component to the natural environment.

Access to the HD Mountains Roadless Area would expand due to extension of the road system from FD Roads 743 and 756. Most of the actual backbone of the HD Mountains Roadless Area would be developed to a density of one to two well pads and about 1 mile of road per section. Portions of the west flank of the Roadless Area would remain undeveloped.

Recreationists attracted to unaltered backcountry settings that the HD Mountains Roadless Area provides, would be probably be displaced by the gas field's development. Recreational use of the south end of the HD Mountains Roadless Area by horseback, hunters, and individuals would also be affected because of the change in access and character of the landscape. Many of the traditional backcountry uses of the southern portion of the HD Mountains Roadless Area would be diminished by the proposed development. However, a large portion of the north and west ends of the HD Mountains Roadless Area would remain unaltered, and would continue to provide backcountry recreation opportunities.

Fosset Gulch: The Area's travel management policy would be changed to limit motorized use to designated roads and trails. Eighty facilities would be developed. The quality of the recreational setting would be reduced because of the visual and audible intrusion of construction and the operation of CBM facilities over the life of wells developed within the area.

The Fosset Gulch landscape would be extensively roaded. Most square-mile sections would have, on average, 1 mile of new access road where generally road access previously did not exist. The change in access and the physical characteristics of the area from mostly undeveloped to highly developed would, consequently, alter the pattern of the area's recreational use and the quality of the recreation setting accordingly.

The number of hunters that utilize Fosset Gulch would probably not change appreciably. The expanded road system would increase ease of access for hunters on foot or on horseback and possibly attract new hunters. Conversely, the change in landscape character would discourage dispersed use by recreationists who prefer a more remote backcountry setting.

The Fosset Gulch area currently receives a moderate level of ATV use that would probably continue with implementation of Alternative 1. Although off-road ATV opportunities would no longer be available, a number of roads and trails would be available for motorized travel (Figure 3–50). Alternative 1 would not impact the small pull offs and spurs off FDR 613 that are popular to car campers and hunters.

3.11.3.1.2 Alternative 2

Alternative 2 involves a greater level of land disturbance and vehicle traffic than Alternative 1, presenting the highest level of recreational impact when compared to the other four alternatives.

Grandview Ridge: Thirteen facilities would be developed near the Grandview Ridge trail system. Consequently, the sights and sounds of well construction and operation would affect the entire system of trails over the life of the project. The quality of the recreational setting would be diminished by the maximum-development alternative.

BLM Dispersed Tracts: Motorized travel would be limited to designated roads and trails. There would be 177 facilities developed on BLM tracts. The access roads to the gas wells would be gated and closed to public motorized use. The quality of the recreation setting would be diminished similar to the impact described for Alternative 1.

Sauls Creek: Motorized travel would be restricted to designated roads and trails. The gas well access roads would be gated and closed to public motorized use. Forty-nine new facilities would be developed. The resulting impacts of CBM development would be greater than described for Alternative 1.

Spring Creek: The overall level of CBM development would be significantly greater than is described for Alternative 1 because the number of facilities developed in Spring Creek would nearly double. Consequently, the quality of the recreational setting would be reduced for many users of the Spring Creek area by the visual and audible effects of construction and the operation of CBM facilities over the life of wells developed within the area.

Some recreationists would abandon the area for less developed landscapes within or near the SJNF. Others would continue to use the area, possibly because of the opportunities presented by an expanded road system, but their recreation would occur in a highly developed landscape. Motorized travel would be restricted to designated roads and trails.

HD Mountains Roadless Area: Motorized use of the area would be limited to designated roads and trails to moderate the impacts of motorized vehicles on the physical environment. There would be 104 facilities constructed on NFS land within the HD Mountains Inventoried Roadless Area, an increase of 79 percent over Alternative 1. The access roads to the gas wells would be gated and closed to public motorized use.

The heart of the Roadless Area, running up and down the spine of the HD Mountains, would now be accessible by road and more readily reached by recreationists. Backcountry recreationists would be displaced. Recreational use through the southern end of the HD Mountains Roadless Area by horseback clubs, hunters, and individuals would also diminish because of the change in access and character of the landscape. Car campers would reach the area from FDR 756, but would continue to be as limited in the extent of access as today because of road closures. Many of the traditional backcountry opportunities in both the northern and

southern portion of the HD Mountains Roadless Area would be diminished by the proposed development.

Fosset Gulch: Motorized travel would be restricted to designated roads and trails. Alternative 2 would involve constructing 113 facilities, a level of development which is 40 percent greater than Alternative 1. The quality of the recreational setting would be reduced for many users by the visual and audible intrusion of construction and the operation of CBM facilities over the life of wells developed within the area. The resultant landscape would be extensively roaded. All square-mile sections would have, on average, 1 mile of new access road, where generally road access previously did not exist. This change in access and the physical characteristics of the area, from mostly undeveloped to highly developed, would alter the patterns of the area's recreational use and the quality of the recreation setting.

The number of hunters, the principal dispersed-recreational users of NFS land in this portion of the Project Area, would not be altered appreciably. On balance, the change in access may attract a different group of hunters, while displacing others. Hunters would no longer experience a backcountry setting.

3.11.3.1.3 Alternative 5 — No Action

Under the No Action Alternative, CBM development would continue on private and state leases but would not be authorized on federal leases in the Project Area. Because no additional development of federal minerals would occur, the resulting federal land impacts would be less than the other action alternatives. Alternative 5 results in recreation impacts on State and private land similar to the Proposed Action

Grandview Ridge: Under this Alternative, the impacts on all recreational uses would be the same as described for Alternative 1.

BLM Dispersed Tracts: Alternative 5 would not alter or change the recreation setting of BLM dispersed tracts. The travel management policy for Alternative 5 would continue to allow motorized use on the BLM land.

Sauls Creek: As a result of additional CBM development on private land, Alternative 5 would slightly alter the recreational setting that currently exists in the Sauls Creek area. The travel management policy for Alternative 5 would continue to allow motorized use within the area, both on and off road or trail. Recreational use of the area would not change from the patterns and types of recreation currently experienced.

Spring Creek: This alternative differs from Alternative 1 in that far fewer wells would be developed and less land would be removed from existing uses during the life of the project. Since fewer wells are envisioned and fewer acres would be disturbed, the impacts on existing recreational uses should be less than the Alternative 1 (the Proposed Action). Recreationists would not encounter additional development on the SJNF.

The travel management policy for Alternative 5 would continue to allow motorized use on NFS land.

HD Mountains Roadless Area: There would be no new CBM development in the HD Mountains Inventoried Roadless Area. Motorized use, both on and off roads or trails on NFS and BLM land, would continue to be permitted. The patterns of recreational use would remain unchanged.

Fosset Gulch: There would be additional development on private and state tracts near Fosset Gulch Road. Overall, however, recreational use of the area, which is centered on the Fosset Gulch Road, would not change.

3.11.3.1.4 Alternative 6

Alternative 6 would require 30 percent fewer well pads (176 vs. 261) and 45 percent less road (65 miles vs. 118 miles) than Alternative 1. Consequently, the physical and visual impacts of implementing Alternative 6 on National Forest would be commensurately less than Alternative 1. Motorized travel would be restricted to designated routes throughout the National Forest lands in the Project Area, similar to Alternative 1

Grandview Ridge: The impacts on all recreational uses would be the same as described for Alternative 1

BLM Dispersed Tracts: The impacts on all recreational uses would be similar to described for Alternative 1.

Sauls Creek: Alternative 6 would be similar to those described for Alternative 1.

Spring Creek: Alternative 6 would have the same impacts on recreation that were described for Alternative 1.

HD Mountains Roadless Area: Surface development would not occur in the HD Mountains Inventoried Roadless Area. Motorized travel would be restricted to existing designated roads and trails. This limitation would decrease recreation vehicle impacts on the physical environment. Except for the change in travel management policy, Alternative 6 would not generate new or different recreation impacts in the HD Mountains Roadless Area than currently exist. The current patterns and types of recreation use would remain unchanged with the area providing primarily for backcountry backpacking, hunting, horseback riding, and day hiking.

Fosset Gulch: Alternative 6 differs from Alternative 1 in that 22 percent fewer wells would be developed within the 1½ mile Fruitland Formation outcrop zone and less land would be removed from existing uses during the life of the project. Since fewer wells are constructed and fewer acres would be disturbed, the impacts on existing recreational uses should be somewhat less than described for Alternative 1.

3.11.3.1.5 Alternative 7

In general, recreational impacts would be less than described for Alternative 1 because fewer roads and well pads would be constructed in the HD Mountains Area. Motorized travel would be restricted to designated routes throughout the NFS lands in the project area, similar to Alternative 1.

Grandview Ridge: The impacts on all recreational uses would be the same as described for Alternative 1

BLM Dispersed Tracts: The impacts on all recreational uses would be similar to described for Alternative 1.

Sauls Creek: Alternative 7 would be similar to those described for Alternative 1.

Spring Creek: Alternative 7 would have the same impacts on recreation that were described for Alternative 1.

HD Mountains Roadless Area: No development would occur within the upper and lower Ignacio Creek, the area south of the Rock Bridge, and the area south of the Relay Tower at this time. Consequently, Alternative 7 would involve less surface CBM development in the HD Mountains Inventoried Roadless Area than Alternative 1. There would be no surface facilities within the Ignacio Creek drainage; therefore the areas current recreation uses would remain unchanged. There would be limited surface development of the current no-surface occupancy leases COC – 64935 and COC-64936. A significant portion of the two leases would remain undeveloped and unchanged from a recreation perspective. The area south of the rock bridge along the Piedra Stock Driveway would also remain undeveloped and unchanged at this time. Lastly, the roadless area accessed to the south from FSR 743 would remain unroaded and unchanged. On balance, approximately 3,000 acres of the HD Mountain's Inventoried Roadless Area would be developed and would revert from backcountry to roaded-modified. This impact would be centered around the Piedra Stock Driveway immediately south of FDR 756 to the rock bridge, and along pockets located on the east flank of the HD Mountains Roadless Area. All roads constructed in conjunction with gas field development would be closed to motorized use. Available recreation opportunities would therefore remain non-motorized, but within a roaded setting where development occurs.

Fosset Gulch: A total of 65 wells and associated roads would be developed in the Fosset Gulch area. The change in access and the physical characteristics of the area from generally undeveloped to extensively developed would alter the pattern of the area's recreational use and the quality of the recreation experience accordingly. The quality of the recreational setting would be reduced because of the visual and audible intrusion of construction and the operation of CBM facilities over the life of development within the area.

The number of hunters, the principal dispersed-recreational use of NFS land in this portion of the Project Area, would probably not change appreciably. The expanded road system would increase access for hunters on foot or on horseback and possibly attract new hunters. Conversely, the change in landscape character would discourage further use of the area by recreationists who prefer more remote backcountry settings.

Some ATV use currently occurs in the Fosset Gulch area and would probably continue with implementation of Alternative 1. Although off-road ATV opportunities would no longer be available, a number of roads and trails would be avail-

able for motorized travel (Figure 3–50). Alternative 7 would not affect the small pull offs and spurs off FDR 613 that are popular to car campers and hunters

3.11.4 Cumulative Effects

The cumulative effects analysis area includes the area where oil and gas development has occurred and will take place within the bounds of the Southern Ute Reservation and the Project Area. A review of the SUIT final EIS for Oil and Gas Development (BLM et al. 2002) indicated that no measurable impacts on recreational resources were expected from construction and operation of wells and associated facilities. There are no predicted effects on recreational opportunities from other reasonably foreseeable oil and gas development in the SUIT study area. Significant portions of the SUIT Study Area are closed to the public by the Southern Ute Indian Tribe or are made available to the public through purchase of a Tribal permit.

Cumulative CBM development in the Project Area consists of existing CBM facilities and the facilities proposed for each alternative. Existing and proposed CBM facilities that affect developed recreational facilities are within visual or audible distance from the recreational facilities. The additive visual impact of proposed well development in the Project Area and the SUIT EIS study area would result in increased degradation of the scenic resource within the cumulative-impacts area. Ongoing CBM development and other land development that occurs with increasing population growth would result in an overall degradation of the natural character and opportunities for solitude that draw many recreationists to the region.

3.11.5 Mitigation and Monitoring

Unless otherwise stated, the companies would fund the following measures:

- Change vehicular travel management throughout the SJNF portion of the Project Area from the current policy that allows motorized vehicle travel off roads or trails to management that restricts motorized travel to designated roads and trails only. Off-road or off-trail motorized travel would be prohibited. (Applies to Alternatives 1 and 2.) Road restrictions that limit road traffic to light company traffic only are an effective means of maintaining wildlife habitat and reducing the possibility of physical land damage resulting from illegal off-road excursions by motorized vehicles.
- Avoid developing wells on trails that cross well windows in the Grandview Ridge and Sauls Creek trail systems. Situate wells to make use of existing terrain and vegetation to screen them from the views of visitors who use the trails or roads that access the trails. Where possible, avoid building well access roads or CBM facilities across or near trails in the Grandview Ridge and Sauls Creek areas. The use of vegetation screening and terrain features to screen facilities is generally an effective visual mitigation measure. The measure is also somewhat effective as a noise mitigation approach, particularly where terrain features are used to separate facilities from areas utilized for recreational purposes.

3.11.6 Conformance to Existing Plans and Policies

3.11.6.1 Conformance with Federal Land Use Plans

The LRMP for the SJNF (FS 1983) establishes direction, standards, and guidelines for managing recreation resources. The standards and guidelines specify the types of recreation that are compatible with, or emphasized in, each Management Area of the SJNF. Each Management Area presents a unique combination of multiple uses.

The SJNF portion of the Project Area contains Management Areas 2A, 3A, 4B, 5B, and 6B. Each of these allows for both motorized and nonmotorized recreation. Within Management Area 3A, motorized recreation must be restricted to designated roads or trails. Alternatives 1 2, 6, and 7 change the travel management policy for the SJNF portion of the Project Area, prohibiting off-road motorized recreation and restricting motorized use to designated roads (Figure 3–50). Current Management Direction allows motorized recreation both on- and off-road. This change in travel management is compatible with direction for recreation management within the five different Management Areas.

Management direction that applies to BLM tracts would not change and would continue to be in conformance with the RMP.

3.11.7 Unavoidable Adverse Effects

Unavoidable adverse effects depend on the perspective and interest of recreationists. Some recreationists, particularly hunters, would be adversely impacted by the restriction of motorized recreation to designated routes. Others who engage in backcountry recreation within the HDs would find a landscape that is more developed and incompatible with primitive backcountry recreation.

The change in landscape character would be greatest in the HD Roadless Area and Fosset Gulch, both of which currently provide backcountry settings. The duration of this change would be at least 25 years, after which well decommissioning and well pad and road obliteration would begin to restore the backcountry landscape. Alternative 2, followed in descending order by Alternatives 1, 6, 7, and 5 would have the greatest impact on dispersed recreation.

Alternatives 1 and 2 would have the greatest impact on recreation and physical setting within the HD Roadless Area; Alternative 5 would have the least impact.

3.11.8 Irreversible and Irretrievable Effects

No irreversible effects would occur. However, primitive backcountry opportunities would be irretrievably affected for the life of the project and beyond. Assuming reclamation of most facilities following project completion, the landscape would slowly revert to pre-project condition, with recreation settings similar to those that currently exist.

3.12 Transportation

3.12.1 Issues

Issue 12: The effects of additional CBM development on transportation and roads.

The following are specific facets of this issue:

- Will new roads provide access to new areas, leading to increased poaching, illegal woodcutting, disturbance of cultural sites, and disturbance to wildlife?
- Will new roads provide access for dirt bikes, four-wheelers, ATVs, and snowmobiles in what is now a roadless area?
- Will gas industry traffic increase, and how will that affect public safety?
- How will industry vehicles affect road surfaces? Will maintenance levels increase? Are road maintenance agreements already in place, and are they enforced?

3.12.2 Affected Environment

The transportation network that serves the Project Area consists of federal and state highways, county roads, NFSRs, and BLM roads. Workers and vehicles that haul equipment and supplies to the Project Area would use this network.

3.12.2.1 Public Road and Highway Network

U.S. Highway 160 is the primary east-west transportation route through La Plata and Archuleta Counties. It links the communities of Durango and Bayfield east to Interstate 25 along the Front Range of Colorado and west to Utah and Arizona. U.S. Highway 550 and State Route 172 extend south from U.S. Highway 160 through the Southern Ute Indian Reservation and into New Mexico. State Route 151 connects U.S. Highway 160 to communities within the Southern Ute Indian Reservation and with the Navajo State Recreation Area. Several smaller paved and unpaved county roads provide access from these primary highways to public and private lands in La Plata County.

The Project Area does not contain any roads maintained by Archuleta County. Most land within the Archuleta County portion of the Project Area is within the Columbine Ranger District of the SJNF. Therefore, with the exception of U.S. Highway 160 and State Route 151, roads within the Project Area in Archuleta County are NFSRs maintained by the SJNF.

Access to existing well sites in the Project Area is from private, county, BLM, and NFS roads that connect with the highway system. La Plata County roads also provide access to residential subdivisions and to isolated rural residences that are located throughout and close to the Project Area. In addition to the network of public roads, an estimated 58 miles of access roads service existing CBM and non-CBM wells on federal, state, and private lands in the Project Area. The aver-

age length of access roads to existing wells is 1,100 feet. Some of these access roads are closed to public use.

3.12.2.2 Federal and State Highways

Annual Average Daily Traffic (AADT) counts for U.S. Highway 160 were obtained from the Colorado Department of Transportation (CDOT). AADTs consist of the annual average of weekly traffic counts calculated from Sunday through Saturday. Table 3-123 provides a summary of current highway conditions, including counts for the stations in the Project Area and a description of the conditions of surface roads.

A Southwest Transportation Planning Region (TPR) transportation system inventory (TSI) concluded that the surface conditions of the regional highway system, including roadways in the Project Area, are generally poor to fair, with large increases in annual daily traffic projected for the next 20 years. The inventory describes existing transportation features, including roadways, trailways, aviation facilities, freight corridors, bicycle and pedestrian corridors, and other transportation facilities.

Three bridges on U.S. Highway 160 within the Project Area are functionally obsolete or are structurally deficient. The bridge over the Florida River, in the western part of the Project Area, is functionally obsolete, as is the bridge over the Los Pinos River overflow. The bridge over the Los Pinos River, on the west side of Bayfield, is structurally deficient.

Existing traffic related to CBM travels on U.S. Highway 160 to reach CBM wells and compressors. There is no discernible impact to daily traffic from CBM vehicle trips, as shown in Table 3-124.

Table 3-123 1998 Annual Average Daily Traffic for U.S. Highway 160 in the Northern San Juan Project Area

Highway Number	Mileposts	Length (Miles)	AADT	Portion Trucks (percent)	Segment Description	Condition	Bridges
160A	86.603 to 101.386	16.189	10,432	10.26	Junction SH 3 N to Junction U.S. 160 Bayfield Business Loop	Poor to good	Florida River Bridge – functionally obsolete
160A	103.176 to 103.624	14.345	4,228	13.77	Road NW (Colorado Road 501) to Junction U.S. 160 Bayfield Business Loop	Poor to fair	(1) Los Pinos River Overflow – functionally obsolete (2) Los Pinos River Structurally Deficient
160E	0.563 to 1.558	1.889	1,979	6.69	Road N (Colorado Road 509) to Road NW (Colorado Road 501) – through Bayfield	Poor to fair	None
160A	103.624 to 117.6	17.769	4,134	13.85	Junction US160 Bayfield Business Loop to Road SE (Colorado Road 7.3)	Poor to fair	None

Notes:
1. Four or more axles-single trailer, 7 or more axle multi-trailer
2. Buses through 4 or fewer axles, single-trailer

Source: CDOT 2001

Table 3-124 Highway Traffic Volume and Level of Service

U.S. Highway 160 segments	1998 Daily Volume	2020 Daily Background Volume	Existing Daily CBM Vehicle Trips for Wells & Compressors	Percent of 1998 Daily Volume from CBM Trips
U.S. 160 - SH3 to Bayfield Bus. Loop	10,432	17,507	47	<1
U.S. 160 Business Loop	1,979	2,703	1	<1
U.S. 160 - CR501 E. to County line	4,134	4,021	19	<1

Source: Southwest Regional Transportation Planning Commission 1999

Movement of freight is limited in La Plata and Archuleta Counties by the mountainous terrain and by seasonal road hazards. U.S. Highways 160 and 550 are, however, part of the hazardous materials route designated by CDOT.

The highest accident rates that resulted in injuries or fatalities on U.S. Highway 160 occurred near Bayfield in the years between 1990 and 1996. The accident rate was 2 or more injuries per million vehicle miles traveled (VMT). No high rates of fatalities occurred along this stretch of the highway during the same period. Instead, most accidents along the highway resulted in damage but no injuries or fatalities. The majority of these accidents occurred east of the intersection of U.S. Highways 160 and 550 and on the stretch of U.S. Highway 160 through Durango. High accident rates that resulted in injuries or fatalities between 1990 and 1996 were not reported for any other location along U.S. Highways 160, 172, or 550.

Recreational and competitive bicyclists as well as bicycle commuters use the highways and the La Plata County Road system. The La Plata County Comprehensive Traffic Study has defined the network of bicycle routes in the county (La Plata County Planning Department 1999). Bicycle routes that in the Project Area are described in Section 3.11.2.1.2 – Dispersed Recreation.

3.12.2.3 County Roads

La Plata County developed a comprehensive traffic study (L Plata County Planning Department 1999) to outline a coordinated strategy to manage and improve the county transportation system for the next 20 years. Phase A of the study surveyed existing road conditions and consisted of information on traffic accidents, a roadway data inventory (signing, striping, and road alignment), speed analysis, and traffic volume counts for selected locations throughout the county. Table 3-125 describes the types of road surfaces and lengths for local and collector roads in the Project Area.

County roads in the Project Area include paved and gravel surfaces. Paved roads are all-weather asphalt with excellent access. Gravel roads are constructed with aggregate material and designed drainage. There are nearly 80 miles of paved and graveled roads in La Plata County throughout the Project Area (Table 3-125).

The TSI identified a bridge on La Plata County Road 234 that crosses the Florida River as functionally obsolete. No other bridges on county roads within the Project Area have been identified as functionally obsolete or structurally deficient.

Table 3-125 Existing Conditions of La Plata County Roads

Route Name	Current Road Classification	Surface Type	Length in Project Area (miles)
213	Local	Gravel	1.39
220	Local	Asphalt	1.78
221	Local	Gravel	1.05
222	Local	Asphalt	1.13
222B	Local	Gravel	NA[1]
223	Local	Gravel	5.81
224	Local	Gravel	0.72
225	Local	Dirt	4.05
225A	Local	Dirt	NA
226 (Rustic Road)	Local	Gravel	0.86
227	Local	Gravel	1.83
227A	Local	Dirt	NA
227G	Local	Gravel	NA
228	Local	Gravel	7.12
229	Local	Gravel	0.99
230	Local	Gravel	1.53
231	Local	Gravel	0.40
232	Local	Gravel	0.52
233	Local	Asphalt	0.97
234	Minor Collector	Asphalt	4.29
235	Local	Gravel	1.51
236	Local	Gravel	0.87
501 (Vallecito Road)	Minor Collector	Asphalt	4.63
502	Local	Gravel	10.08
503	Local	Gravel	1.38
503A	Local	Gravel	NA
503B	Local	Gravel	NA
504	Local	Gravel	1.28
505	Local	Gravel	2.35
505A	Local	Gravel	NA
506	Local	Gravel	0.44
507	Local	Asphalt	0.81
509	Local	Asphalt	0.82
509	Local	Asphalt	1.04
510	Local	Gravel	1.91
516	Local	Asphalt	0.88
521 (Buck Highway)	Major Collector Rural	Asphalt	1.24
523	Minor Collector Rural	Gravel	NA
526	Local	Gravel	3.16
527	Local	Gravel	3.75
528	Local	Dirt	1.35
Total			79.53

Note:
1. NA = not described in Comprehensive Traffic Study
Source: La Plata County Planning Department 1999

All of the county roads in the Project Area are expected to experience substantial increases in traffic, reflecting a projected increase in population of nearly 56 percent in La Plata County between 1998 and 2020 (Colorado Department of Local Affairs 2001c). The largest increases in traffic are expected for County Roads 225, 229, 501, 502, and 509.

The traffic study projected future residential growth along highways and county roads for the 10 planning districts within La Plata County. The Project Area contains portions of three of these districts: Bayfield, Southeast La Plata, and Florida Mesa. The projected growth in the resident population and housing units along county roads in the Bayfield Planning District is 179 percent from 1998 through 2020. The projected growth along county roads in the Southeast La Plata District is 129 percent, and the growth projected for Florida Mesa is 31 percent. The projected population growth for La Plata County for this period is 56 percent.

The traffic study analyzed records for La Plata County to identify the number of accidents that occurred on county roads from January 1991 through August 1998. The data were used to isolate locations of multiple accidents and thus to identify segments of the county roads with safety issues. Accident rates are high on four county roads within the Project Area. County Road 501 includes four locations where the rate of accidents is high; one location is identified for each of the other road segments. These locations are summarized on Table 3-126. Records compiled by La Plata County indicate that the majority of accidents occur at intersections. According to the La Plata County Office of Emergency Management, an estimated six to 10 traffic incidents per year involve CBM-related vehicles. These vehicles are mostly water trucks used for dust control on access roads. No other data describe incidents that involve CBM-related vehicles in the Project Area.

Table 3-126 Summary of Accident Locations and Recommended Improvements for La Plata County

County Road	High Accident Location	Number of Accidents at High Accident Location	Number of Accidents on Entire Road	Accident Rate[1]	Recommended Safety Improvements[2]
CR 228	0.4 mile E of CR 224	5	22	4.83	None
CR 234	3.1 mile N of U.S. 160	6	26	2.41	Roadway Realignment
CR 501	-Intersection of U.S. 160	10	130	1.20	None
	-0.1mile N of Sossaman Rd.	4		0.55	Construct Auxiliary Lands and Bridge Replacement
	-Intersection of CR 502	5		1.13	Roadway Realignment
	-0.2 mile S of CR 500	7		2.01	None
CR 509	Intersection of U.S. 160B	6	20	2.39	None

Note:

1. The accident rate was calculated by dividing the number of accidents (per one million vehicles traveling past the significant accident locations) by the total number of vehicles (average daily traffic [ADT] multiplied by the survey duration of 2,770 days).
2. Safety improvements for road segments with high accident rates were identified in the La Plata County Comprehensive Traffic Study (La Plata County Planning Department 1999).

The traffic study identified three alternatives to mitigate large truck traffic. The first alternative recommends that companies responsible for truck traffic be required to construct improvements that are directly needed by the operation. Potential improvements include paving a gravel roadway and improving intersections and sight distances. The second alternative is a permitting process for trucks that drive on county roads. The permit would generate revenue that would address the impacts of trucks on county roads. A third alternative is increased effort to enforce existing regulations for overweight vehicles. The impacts of violations by overweight vehicles can be significant on low-volume county roads. No maintenance or compensation agreements currently have been reached between the companies and the county.

3.12.2.4 BLM Roads

Public land administered by the BLM is the smallest ownership type in the Project Area (Table 3-110). BLM lands consist of isolated tracts surrounded by private property. No BLM system roads are found within the Project Area. However, primitive roads or trails connect at least three parcels with county roads. An estimated 4.1 miles of access roads service CBM wells on BLM lands.

3.12.2.5 National Forest System Roads

Current management direction for NFSRs is to provide the minimum facilities and maintenance needed to safely accommodate the expected type and volume of traffic. Access routes on NFS lands in the Project Area include gravel and dirt roads and trails. The volume of traffic, type of surface, condition, and status of use for each numbered NFSR are summarized on Table 3-127. Conditions on NFS lands were verified in the field.

In addition to numbered NFSRs, un-numbered roads also cross NFS lands in the Project Area. These roads are primarily short, gravel-surfaced spurs used to access oil and gas wells, are in fair to good condition, and are open to all motor vehicles. An estimated 5.3 miles of roads currently serve CBM wells on NFS lands in the Project Area.

Access to NFSRs and NFS lands is gained via U.S. Highway 160, several primary county roads, and NFSRs. La Plata County Road 527 provides access to NFS lands directly from U.S. Highway 160. La Plata County Roads 523 and 525 provide access to Armstrong Canyon and Spring Creek. Sauls Creek (NFSR 608), Spring Creek (NFSR 537), and Fosset Gulch (NFSR 613) are the major NFSRs used to access the Project Area. These three improved light-duty gravel NFSRs connect with several smaller roads to form a network that provides access to most of the Project Area. NFSR 743 accesses a radio tower on the northeastern part of the Project Area. Many existing NFSRs provide access to existing oil and gas wells.

As described in Table 3-127, many NFSRs are closed periodically for various reasons. In general, NFSRs in the Project Area are completely or partially closed during the winter because the Forest Service does not plow snow. Additionally, roads to Lange Canyon (NFSR 132), Sauls Creek, Turkey Creek (NFSR 615), and Spring Creek are closed seasonally to protect wildlife.

Table 3-127 Conditions of National Forest Road in the Project Area

				Open to[1]:				
NFSR	ADT	Surface Type	Condition	Passenger Vehicles	ATVs/ Motorcycle	Admin Use	Oil & Gas	Notes
123	NA	Gravel/Dirt	Fair	P1	Y1	Y2	Y3	
125	NA	Primitive	Poor	N1	Y1	Y2	N	
126	NA	Primitive	Poor	N1	Y1	Y2	N	Inadequate maintenance
127	NA	Primitive	Poor	N1	Y1	Y	N	Inadequate maintenance
131	NA	Gravel	Good	P1	Y1	Y	Y	Inadequate maintenance
131.A	NA	Gravel	Good	Y1	Y1	Y	Y	
132	NA	Gravel/Dirt	Good to poor	Y1	Y1	Y	Y	Gravel section is in good to fair condition, dirt section is in fair to poor condition. Blocked culvert.
135	NA	Gravel	Good	Y	Y	Y	Y3	Closed road not properly signed and blocked.
537	10-25 CR 335	Gravel	Good to Fair	Y1	Y1	Y	Y	Lower portion in good condition, upper portion in fair condition.
537.0	NA	Dirt	Poor	Y1	Y1	Y	Y	
537.A	NA	Dirt	Poor	Y1	Y1	Y	Y	
607	NA	Primitive	Poor	N	Y	Y2	N	
608	20-50 CR 527	Gravel	Good	Y1	Y1	Y	Y	
608.A	NA	Gravel	Good	P1	Y1	P	P	
608.B	NA	Gravel	Fair	Y1	Y1	Y	Y	
610	NA	Primitive	Poor	N1	Y1	Y2	N	Inadequate maintenance
610.1	NA	Primitive	Poor	N1	Y1	Y2	N	Inadequate maintenance
612	NA	Gravel	Good	N	N	Y	N	
613	NA	Gravel	Fair to poor	Y	Y	Y	Y	Partially blocked culvert, restricted bridges.
615	NA	Gravel/ Primitive	Fair to poor	N1	Y1	Y	Y	Gravel section is in good to fair condition, primitive section is in fair to poor condition.
615.A	NA	Gravel/Dirt	Fair to poor	Y1	Y1	Y	Y	Gravel section in fair condition. Dirt section in poor condition.
743	NA	Gravel	Good to fair	Y	Y	Y	Y3	Two large slumps along fill slopes near tower.
755	NA	Gravel	Good	Y1	Y1	Y	Y	
755.A	NA	Gravel	Good	Y1	Y1	Y	Y	
756	NA	Dirt	Fair to poor	Y1	Y1	Y	Y3	
841	NA	Dirt	Fair to poor	N	Y	Y	Y3	Stream crossing improvements needed
841.B	NA	Dirt	Fair to poor	N	Y	Y	Y3	
841.C	NA	Dirt	Fair to poor	N	Y	Y	Y3	
841.E	NA	Dirt	Fair to poor	N	Y	Y	Y3	
842	NA	Dirt	Fair	Y	Y	Y	Y	
924	NA	Dirt	Fair	Y	Y	Y	Y3	

Note:
1. Y = Open, N = Closed, P = Partially open. 1 = Seasonal closure to protect wintering big game, 2 = Open to administrative use, but accessible by ATVs and motorcycles only, and 3 = Open to oil and gas use, but not used for this purpose.

Source: FS 2003b

The FS standards and guidelines (FS 1983) specify densities for open local roads for each of the five management areas within the Project Area. The existing density of roads for Management Area 6B exceeds the guidelines in the LRMP, as shown on Table 3-128. FS classified open roads in the remaining management areas meet the forest standards.

Table 3-128 Existing Road Density for Management Areas in the Analysis Area

	Road Density (miles of road per square mile)		Forest Plan Standard (miles of road per square mile)
Management Area	FS Classified Open	FS Classified Closed/Unclassified	Local open roads
2B	0.39	0.14	0.5 to 1.0
3A	0.83	0.96	No standard
4B	0.19	0.15	0.5 to 1.0
5B	0.34	0.23	0.0 to 0.5
6B	1.36	0.91	0.5 to 1.0

Source: FS 1983

The existing road system adequately reflects the need to connect public roads and provide access to the Project Area. The road system (primarily NFSR 121) provides adequate access to cabins and other improvements on private lands in the Project Area. State Highway 65 crosses the Project Area and is connected to several NFSRs that provide the primary access to adjacent public lands. Each part of the existing road system has been built to safely accommodate the anticipated uses. However, there may be outstanding safety issues based on the high level of use on several of these roads (for example, on NFSRs 121 and 123).

3.12.2.6 Oil and Gas Industry Traffic

CBM traffic has traveled on county roads in La Plata and Archuleta Counties since the mid-1980s. In fact, the first CBM production in the area occurred in 1951 within the nearby Southern Ute Indian Reservation. However, little development occurred in the San Juan Basin until 1980, when the Crude Oil Windfall Profits Tax Act was enacted and industry improved the technical capability for CBM production.

CBM has been the focus of natural gas development in the SJB since 1988. Despite this history of development, no complaints have been lodged against the industry that have identified damage to county roads from CBM vehicles. However, heavy trucks do cause more damage to road surfaces of all types than do automobiles and light trucks.

Traffic related to development of oil and gas in the Project Area consists of vehicle trips associated with installation of wells, compressors, and pipelines, and with maintenance of the facilities. Table 3-129 summarizes the number of annual and daily vehicle trips typically attributed to CBM and non-CBM traffic in the NSJB.

Table 3-129 Baseline Trip Generation by CBM Wells

Parameter	Active CBM	Active non-CBM	Total
Project Area			
Number of Wells	276	34	310
Annual Trips	12,775	1,460	14,235
Daily Vehicle Trips	35	4	39
National Forest			
Number of Wells	25	0	25
Annual Trips	1,100	0	1,100
Daily Vehicle Trips	3	0	3
BLM			
Number of Wells	20	10	30
Annual Trips	1,100	365	1,465
Daily Vehicle Trips	3	1	4

Source: BLM et al. 2002

Maintenance occurs over the life of the facilities and consists of well workovers and other operations. The transportation analysis assumed that active production wells and disposal or injection wells would continue to require daily maintenance trips that total 365 per year and an annual workover (six trips per workover). Thus, 371 trips per CBM and non-CBM well would be required annually for maintenance, on average (Table 3-129).

Daily service trips must be factored by the average number of well sites each service crew can visit in 1 day to compute daily vehicle trips for all wells in the Project Area. It was assumed for this analysis that one service crew can visit eight wells per day. Daily vehicle trips would equal the number of annual service trips divided by 365 days per year divided by 8 wells per service crew. Thus, personnel for all companies combined would make 39 daily service trips (Table 3-129).

Six compressors currently serve the Project Area. Table 3-130 summarizes baseline number of annual compressor maintenance trips. Each compressor site currently requires daily maintenance trips, for a total of 365 per year (pickup and crew cab visits), and an annual workover (one site per visit per multi-axle vehicle). This analysis assumed that each service crew can visit four sites per vehicle per day. Daily vehicle trips average 1.5 vehicles per day, which is less than 1 percent of total average daily traffic on all state highways or county roads within the Project Area.

The agencies recognize that some smaller compressors are collocated with wells at some sites and that both facilities may be maintained in a single trip to the site. However, both facilities are not always maintained with a single trip. Consequently, the analysis conservatively treated these compressors as stand-alone facilities in counting vehicle trips.

Table 3-130 Compressor Maintenance Vehicle Trip Generation – Baseline

Number of Compressors	Average Number of Trips Generated	Annual Service Trips per Unit	Annual Trips	Daily Vehicle Trips[1]
6	7 to 14 crew cab/pickup visits per week	546	3,276	1.5
6	1 multi-axle visit per year	1	6	<1
Total Compressor Maintenance Trips Generated			2,188	1.5

Note:
1. One daily vehicle trip = annual trips/365/4 sites per vehicle per day.
Source: BLM et al. 2002

Estimates of the current number of vehicle trips for maintenance of compressors and wells associated with each segment of county road were developed based on the methodology in the La Plata County Comprehensive Traffic Study to project population and housing growth in the County. Section 3.1.5 of that study summarizes the methodology, which is based on road segments and associated land parcels. Each County land parcel was assigned to a road segment primarily based on locations and connectivity of minor roads, topography, and local knowledge. The road segments identified in the process were used to estimate existing CBM vehicle traffic. The traffic related to CBM was linked to road segments and roads were rated as low, medium, and high to indicate the level of impact from additional CBM traffic on roads in the Project Area.

3.12.3 Environmental Consequences

The analysis of transportation impacts addresses the effects of the five development alternatives on the network of roads in the Project Area. Each alternative would result in an increase in CBM gas industry traffic. CBM-related traffic travels between well sites and staging areas on highways and county roads and may affect local traffic patterns, create safety problems, and damage roads. The majority of CBM traffic would travel on roads that are under the jurisdiction of La Plata County and the San Juan National Forest. County roads in the Project Area are generally designed for light-duty traffic and connect residential subdivisions and rural tracts with U.S. Highway 160, Durango, and Bayfield.

3.12.3.1 Alternative 1 — Proposed Action

Four types of impacts are of concern: (1) the effects of additional traffic on county roads and roadway congestion; (2) the potential for traffic accidents to increase in the Project Area; and (3) the potential for conflicts with public access to existing residential uses from CBM traffic on county roads, as well as from construction and operation of well access roads and (4) the potential for new roads to result in increase in poaching and other impacting activities.

CBM-related traffic consists of construction vehicles that would build access roads and well pads and vehicles that haul components of the drill rig, other equipment, and supplies. Typical vehicles include a tractor dozer, tractor/ backhoe, road grader, gravel trucks, and light trucks used to transport employees. It is anticipated that CBM construction would proceed at a rate that requires four

drill rigs operating on an annual basis, limited to seasonal restrictions. An average of two round trips per construction of each segment of road would be required for the trucks that haul the dozers, graders, and backhoes. An average of three round trips per day by management and worker vehicles (pickups) would occur for the duration of road construction. Ten to 12 days likely would be required to drill each target well.

Traffic levels and impacts that result from long-term CBM production operations would consist of daily light truck travel by employees involved in operations, metering, and maintenance of production wells, flowlines, and compression facilities. Facility maintenance would occur daily during each year over the life of the CBM production anticipated, with an additional six trips over 1 to 2 days for an annual workover.

3.12.3.1.1 Federal Highway Network

U.S. Highway 160 is the only federal highway that would be used by CBM-related traffic in the immediate Project Area. The daily volume of traffic on most segments of U.S. Highway 160 is expected to increase substantially between 1998 and 2020, as shown on Table 3-131. The number of vehicle trips proposed for CBM facilities that would use the highway as the primary route to reach access roads to wells is small, generally less than one-percent, relative to existing traffic, and to projected daily background traffic in 2020. The number of vehicle trips to service BLM and FS wells is proportional to the number of wells and trips generated as described in Table 3-131. Assuming development occurs over 5 years, there would be no discernible impact to daily traffic from CBM vehicle trips.

Several roadway projects have been identified in the Southwest Colorado 2020 Transportation Plan. This analysis projects level of service (LOS) only to 2020 because comparative data for this area have not been developed beyond 2020. None of the projects identified in the Plan includes widening or other improvements that would increase the capacity on U.S. Highway 160. It is likely that the projected LOS classes for 2016 would apply to traffic conditions projected for 2020.

Any potential increase in the rate of accidents from CBM vehicles would occur over the life of anticipated CBM production. Construction traffic includes vehicles that range in size and weight from light to heavy trucks. Maintenance traffic, however, generally consists of light trucks. As shown on Table 3-132, the increase in daily traffic levels projected from anticipated CBM-related traffic is less than one-percent. There would be no perceptible effect on the overall rate of accidents on highways because the volume of traffic from anticipated CBM development on most of these roads is projected to be less than one-percent.

The locations along U.S. Highway 160 where conflicts between CBM vehicles and other highway traffic are most likely to occur are at intersections where CBM vehicles turn onto highways from access roads.

Table 3-131 Summary of Average Daily Traffic Count for Existing Daily Trips for CBM Wells and Compressors for Selected La Plata County Roads

Route Name[2]	Location	ADT for All Vehicle Types: 1998 ADT	ADT for All Vehicle Types: Projected 2020 ADT	Daily Trips for Existing CBM Wells[1]: Average Daily Trips (incl. in ADT for all vehicles)	Daily Trips for Existing CBM Wells[1]: Percent Included in 1998/2020 ADT
CR 220	2.3 Mile W of SH 172	1,817	3,579	2	<1.0/<1.0
CR 220	0.67 Mile W of SH 172	1,378	2,715	3	<1.0/<1.0
CR 223	1 Mile E. of CR 225	245	385	27	2.9/1.8
CR 225	0.67 Mile N. of CR 223	574	1,366	1	<1.0/<1.0
CR 225	2.81 Mile N. of CR 223	427	1,017	2	<1.0/<1.0
CR 228	0.31 Mile E. of CR 234	289	690	2	<1.0/<1.0
CR 228	2.02 Mile E. or CR 225	374	895	3	<1.0/<1.0
CR 229	0.26 Mile N. of U.S. 160	562	1,404	1	<1.0/<1.0
CR 233	0.53 Mile N. of U.S. 160	330	491	2	<1.0/<1.0
CR 234	2.1 Mile N. of U.S. 160	898	1,401	1	<1.0/<1.0
CR 234	0.5 Mile N. of U.S. 160	1,249	1,948	0	0
CR 501	4.2 Mile N. of U.S. 160	2,182	5,346	16	<1.0/<1.0
CR 502	0.77 Mile N. of U.S. 160	707	1,950	2	<1.0/<1.0
CR 502	3.4 Mile N. of U.S. 160	342	945	7	2.0/<1.0
CR 509	0.56 Mile S. of U.S. 160	907	2,784	1	<1.0/<1.0
CR 510	0.52 Mile E. of CR 222	883	1,854	2	<1.0/<1.0

Notes:
1. Each well requires a daily maintenance trip and an annual workover (6 trips per workover) for a total 371 trips per year per well, or 1.02 daily trips per well. The total daily trips per well have been rounded to the nearest whole number in the table.
2. Road segments from the La Plata County Comprehensive Traffic Study correspond to road segments presented in this table to compare traffic volumes.
Source: La Plata County Planning Department 1999

Table 3-132 Highway Traffic Volume and LOS – Alternative 1

Highway (segment) US Highway 160	1998 Daily Volume	1998 LOS	Projected 2020 Daily Background Volume	Projected 2020 LOS	Projected Daily CBM Vehicle Trips	Percent Increase in Daily Background Volume from CBM Trips
US Highway 160 - SH3 to Bayfield Bus. Loop	10,432	E	17,507	F	16	<1
US Highway 160 Business Loop	1,979	E	2,703	F	3	<1
US Highway 160 - CR501 E. to county line	4,134	E	4,021	F	8	<1

Notes:
LOS E – operating conditions near or at capacity
LOS F – forced or breakdown flow conditions
Source: Southwest Regional Transportation Planning Commission 1999

Most of the freight that moves through the Project Area is hauled in heavy trucks, which has resulted in concerns about deterioration of road surfaces. Heavy trucks are responsible for a disproportionate amount of pavement damage on highways. Heavy trucks would account for about 25 percent of proposed CBM construction vehicle traffic on U.S. Highway 160. However, daily construction trips by heavy vehicles would be spread out over the 5-year construction period. Each of the 284 proposed wells would require about six trips by heavy construction vehicles over the construction period of 2 weeks per well. The number of wells that would be drilled within the Project Area would vary over the 5-year construction period; however, an average of one to two wells would be installed every week during the construction period. Therefore, heavy construction vehicles would make an estimated total six to 12 trips over each 2-week period within the Project Area. The number of heavy construction vehicles would be considerably less than 1-percent on any segment of U.S. Highway 160 within the Project Area. Trucks utilized to construct federal wells would contribute about ⅔ of the six to 12 trips per two-week total.

According to the Transportation System Inventory (Southwest Regional Transportation Planning Commission 1999), surface conditions on U.S. Highway 160 range from poor to fair. Current conditions indicate that highway maintenance practices have not kept pace with increased traffic levels that have resulted from the growing population of La Plata and Archuleta Counties. The Southwest Regional Transportation District has identified several improvement projects for the highway within the Project Area. U.S. Highway 160 is a freight route, with approximately 7 to 14 percent truck traffic on highway segments in the Project Area. It is not anticipated that CBM traffic would result in significant degradation of the road surface. The number of heavy construction vehicles would be considerably less than 1 percent on any segment of U.S. Highway 160 within the Project Area.

3.12.3.1.2 County Transportation Network

The volume of traffic on county roads that would result from anticipated CBM development in the Project Area was estimated from the methods to generate trips to wells and compressors that are presented in Section 3.12.2.6. This methodology and the following significance criteria have been used for the analysis of impacts to transportation for other oil and gas developments in southwest Colorado. These criteria indicate whether an impact, a significant impact, or no perceivable impact would occur.

An impact would occur if CBM development were projected to generate 10 percent or more additional daily vehicle trips over the number that is expected to occur without further development of oil and gas in the Project Area. These criteria were developed in the BLM's FEIS for Oil and Gas Development on the Southern Ute Indian Reservation (BLM et al. 2002). A significant impact on the volume of traffic would exist if anticipated CBM development were projected to generate 25 percent or more additional daily vehicle trips. Traffic from CBM development would have no perceivable impact if it generates less than 10 percent of additional vehicle daily trips. Table 3-133 summarizes daily trips associated with existing and anticipated CBM wells in the Project Area, and compares the trips with the average daily traffic (ADT) volume of all vehicle types for 1998 and the projected ADT in 2020 for selected roads in La Plata County. The table

shows that increases generated by CBM maintenance traffic are less than 10 percent of additional average daily trips (generally less than 1 percent) on the selected segments of county roads and therefore would have no perceivable impact.

The maximum maintenance traffic from CBM development that would be added to existing traffic on roads in the Project Area from all vehicle types is less than 1 percent of the total daily levels for most affected county roads. There is, therefore, no significant impact on the volume of traffic because projected CBM-related vehicles would not generate 25 percent or more additional daily vehicle trips on any county roads in the Project Area. The projected CBM-related vehicles would generate less than 10 percent of additional daily vehicle trips on all affected county road, with the exception of CR 223, therefore, there would be no perceptible impact to the volume of traffic on county roads in the Project Area. Traffic to and from existing federal wells contributes to approximately ½ of daily trips described in Table 3-131. Traffic to and from proposed federal wells would contribute to approximately 1/10 of the totals daily trips on County roads in the western Project Area and ⅔ of the daily trips on County roads in the western Project Area that access the National Forest.

Traffic levels and impacts that would result from construction-related activities are expected to be short term, lasting from a few days to a few months in any specific area. Traffic on roads that would be crossed by flowlines would experience minor delays caused by lane closures during construction. The remaining lanes would be capable of handling the expected traffic.

The largest increases from CBM-related traffic would occur on CR 223, averaging 27 daily vehicle trips for each year through 2020. CR 223 provides access to BLM, private and State wells. The maximum projected ADT for all vehicles is 385 in 2020. The total daily traffic of about 412 vehicles in 2020 is within the maximum design capacity of 999 for CR 223. CR 225 and CR 501 are the other county roads that would experience increases that exceed 1 percent in daily traffic from additional CBM maintenance vehicles. These increases slightly exceed 1 percent of the ADT for the base year of 1998.

Records compiled by La Plata County indicate that the majority of accidents occur at intersections. There is a potential for increased accident rates from traffic conflicts with vehicles that are involved in construction of access roads and well pads. These construction vehicles would also be involved in well drilling, completion, and installation, which would occur over the construction period of 6 to 12 days per well. The disparity in size and weight between passenger vehicles (automobiles and light trucks) and the medium to heavy trucks required for construction of CBM facilities could result in an increase in accidents that are fatal or cause serious injury.

Four county roads in the Project Area include segments where the rate of accidents is high: CR 228, CR 234, CR 501, and CR 509. These roads provide access to residential subdivisions within and north and south of the Project Area. As shown on Table 3-133, the increase in daily traffic levels projected from anticipated CBM-related maintenance traffic is small between 2003 and 2020. Impacts beyond 2020 are expected to be similar in magnitude and intensity. There would be no perceptible effect on the overall rate of accidents rates on county roads be-

cause the volume of traffic from anticipated CBM development on most of these roads is projected to be less than 1 percent.

3.12.3.1.3 CBM Traffic Conflicts with other Land Uses

Anticipated CBM development in the Project Area is located in an area of ongoing growth of residential uses on private lands (see Land Use section of this chapter). The primary county roads used for residential access include CRs 223, 228, 501, 502, 504, and 505. Future residential growth is likely to occur along these same corridors.

The greatest increases in volume of CBM construction and maintenance traffic would occur on segments of CRs 223, 228, 501, 502, 504, 505, and 527. With the exception of CR 527, these roads are the same used to access existing and future residential development. The potential for conflicts with CBM-related traffic is highest along these roads. Two of these roads (CRs 228 and 501) are locations of high rates of accidents.

Table 3-134 estimates, by vehicle weight, the number of trips required for construction and installation of wells on selected La Plata County roads. The table shows the proportionate impact that is anticipated by vehicles in various weight classes. The estimate of daily trips by construction vehicles on each road assumed that all construction and installation would require 2 weeks per well. The estimate further assumed that construction would be spread out over 5 years. The number of trips estimated for each road segment that would bear traffic from more than one well would not necessarily occur either simultaneously or consecutively, but may occur during any 2-week period over the 5-year construction phase.

Conflicts between CBM and local residential traffic in the Project Area would be most likely to occur during the 2-week construction period for each well, as heavy trucks hauling supplies and equipment use county roads that also provide access to residential areas. It is anticipated that any increases in traffic levels at any one time on county roads would fall within the capacity of the roads; however, the potential for incidents would increase at intersections where project-related traffic turns onto county roads.

In addition, residents and recreationists near proposed CBM facilities would be affected by the sight and sound of vehicles delivering material and supplies to each well site, and by construction vehicles engaged in well drilling and construction. Residential areas in the Project Area are located on private lands in La Plata County. Residential uses consist of dispersed uses on NFS lands, trail systems on NFS and BLM lands, and private campgrounds.

3.12.3.1.4 Road Maintenance

CBM-related traffic would increase the number of heavy trucks on county roads. The daily traffic trips for all vehicle weight classes, as shown on Table 3-134, is a conservative scenario that assumes that all wells associated with each road segment would be drilled within the same 2-week period.

Table 3-133 Summary of Average Daily Traffic Count, Existing and Anticipated Daily Trips for CBM Wells and Compressors for Selected La Plata County Roads in the Project Area

		ADT for All Vehicle Types		Daily Trips for Existing CBM Wells[1]		Daily Trips for Anticipated CBM Facilities[1]		Cumulative Daily Trips	
Route Name[2]	Location	1998 ADT	Projected 2020 ADT	Average Daily Trips (incl. in ADT for all vehicles)	Percent included in 1998/2020 ADT	Average Daily Trips	Percent Increase in 1998/2020 ADT	Average Daily Trips	Percent Increase in 1998/2020 ADT
CR 220	2.3 Mile W of SH 172	1,817	3,579	2	<1.0/<1.0	1	<1.0/<1.0	3	<1.0/<1.0
CR 220	0.67 Mile W of SH 172	1,378	2,715	3	<1.0/<1.0	0	0	3	<1.0/<1.0
CR 223	1 Mile E. of CR 225	245	385	27	11.0/7.0	13	5.3/3.4	40	16.3/10.4
CR 225	0.67 Mile N. of CR 223	574	1,366	1	<1.0/<1.0	0	0	1	<1.0/<1.0
CR 225	2.81 Mile N. of CR 223	427	1,017	2	<1.0/<1.0	2	<1.0/<1.0	4	<1.0/<1.0
CR 228	0.31 Mile E. of CR 234	289	690	2	<1.0/<1.0	3	1.0/<1.0	5	1.7/<1.0
CR 228	2.02 Mile E. or CR 225	374	895	3	<1.0/<1.0	5	<1.0/<1.0	8	2.1/<1.0
CR 229	0.26 Mile N. of US Highway 160	562	1,404	1	<1.0/<1.0	0	0	1	<1.0/<1.0
CR 233	0.53 Mile N. of US Highway 160	330	491	2	<1.0/<1.0	0	0	2	<1.0/<1.0
CR 234	2.1 Mile N. of US Highway 160	898	1,401	1	<1.0/<1.0	0	<1.0/<1.0	1	<1.0/<1.0
CR 234	0.5 Mile N. of US Highway 160	1,249	1,948	0	0	0	<1.0/<1.0	0	<1.0/<1.0
CR 501	4.2 Mile N. of US Highway 160	2,182	5,346	16	<1.0/<1.0	9	<1.0/<1.0	25	1.1/<1.0
CR 502	0.77 Mile N. of US Highway 160	707	1,950	2	<1.0/<1.0	0	0	2	<1.0/<1.0
CR 502	3.4 Mile N. of US Highway 160	342	945	7	2.0/<1.0	1	<1.0/<1.0	8	<1.0/<1.0
CR 509	0.56 Mile S. of US Highway 160	907	2,784	1	<1.0/<1.0	0	0	1	<1.0/<1.0
CR 510	0.52 Mile E. of CR 222	883	1,854	2	<1.0/<1.0	1	<1.0/<1.0	3	<1.0/<1.0

Notes:
1 Each well requires a daily maintenance trip and an annual workover (6 trips per workover) for a total 371 trips per year per well, or 1.02 daily trips per well. The total daily trips per well have been rounded to the nearest whole number in the table.
2 CR = County road, SH = State highway
Source: La Plata County Planning Department 1999

Table 3-134 Projected Alternative 1 CBM Vehicle Trips for Construction Activities by Road Segment

Road Segments	Number of Proposed Wells	Trip Frequency for Light Vehicles[1]	ADT for Light Vehicles	Trip Frequency for Medium Vehicles[1]	ADT for Medium Vehicles	Trip Frequency for Medium Heavy Vehicles[1]	ADT for Medium Heavy Vehicles	Trip Frequency for Heavy Vehicles[1]	ADT for Heavy Vehicles
CR 213 - U.S.550/160 south to CR214	0	0	0	0	0	0	0	0	0
CR 220 – CR 301 east to SR172	0	0	0	0	0	0	0	0	0
CR 220 - U.S.550 east to CR301	1	100	7	67	5	88	6	87	6
CR 221 – CR 222 east to end	1	100	7	67	5	88	6	87	6
CR 221 – SR 172 east to CR 222	0	0	0	0	0	0	0	0	0
CR 222 – CR 510 south to SR172	0	0	0	0	0	0	0	0	0
CR 222 - U.S.160 south to CR510	0	0	0	0	0	0	0	0	0
CR 223 – CR 225 east to U.S.160	13	1,300	93	871	62	1,144	82	1,131	81
CR 223 - U.S.160 north to CR 230	0	0	0	0	0	0	0	0	0
CR 224	0	0	0	0	0	0	0	0	0
CR 225 – CR 223 north to CR226	0	0	0	0	0	0	0	0	0
CR 225 – CR 226 north to CR228	0	0	0	0	0	0	0	0	0
CR 225 – CR 228 north to CR234	2	200	14	134	10	176	13	174	12
CR 226	0	0	0	0	0	0	0	0	0
CR 227	0	0	0	0	0	0	0	0	0
CR 228 – CR 224 east to CR502	5	500	36	335	24	440	31	435	31
CR 228 – CR 225 east to CR224	3	300	21	201	14	264	19	261	19

Table 3-134 Projected Alternative 1 CBM Vehicle Trips for Construction Activities by Road Segment

Road Segments	Number of Proposed Wells	Trip Frequency for Light Vehicles[1]	ADT for Light Vehicles	Trip Frequency for Medium Vehicles[1]	ADT for Medium Vehicles	Trip Frequency for Medium Heavy Vehicles[1]	ADT for Medium Heavy Vehicles	Trip Frequency for Heavy Vehicles[1]	ADT for Heavy Vehicles
CR 228 – CR 229 north to CR225	0	0	0	0	0	0	0	0	0
CR 228 – CR 234 east to CR229	0	0	0	0	0	0	0	0	0
CR 229 – CR 230 north to CR228	0	0	0	0	0	0	0	0	0
CR 229 - U.S.160 north to CR 230	0	0	0	0	0	0	0	0	0
CR 230	1	100	7	67	5	88	6	87	6
CR 232	0	0	0	0	0	0	0	0	0
CR 233	0	0	0	0	0	0	0	0	0
CR 234 – CR 225 north to CR237	0	0	0	0	0	0	0	0	0
CR 234 – CR 228 north to CR235	0	0	0	0	0	0	0	0	0
CR 234 – CR 235 north to CR236	0	0	0	0	0	0	0	0	0
CR 234 – CR 236 north to CR225	0	0	0	0	0	0	0	0	0
CR 234 – CR 237 north to CR240	0	0	0	0	0	0	0	0	0
CR 235	1	100	7	67	5	88	6	87	6
CR 236	0	0	0	0	0	0	0	0	0
CR 501 - U.S.160 north to Forest Lakes	8	800	57	536	38	704	50	696	50
CR 502 – CR 228 east to CR 503	0	0	0	0	0	0	0	0	0
CR 502 – CR 245 west to CR 228	4	400	29	268	19	352	25	348	25
CR 502 – CR 503 east to CR 504	2	200	14	134	10	176	13	174	12

Table 3-134 Projected Alternative 1 CBM Vehicle Trips for Construction Activities by Road Segment

Road Segments	Number of Proposed Wells	Trip Frequency for Light Vehicles[1]	ADT for Light Vehicles	Trip Frequency for Medium Vehicles[1]	ADT for Medium Vehicles	Trip Frequency for Medium Heavy Vehicles[1]	ADT for Medium Heavy Vehicles	Trip Frequency for Heavy Vehicles[1]	ADT for Heavy Vehicles
CR 502 – CR 504 east to CR 505	2	200	14	134	10	176	13	174	12
CR 502 – CR 505 south to U.S.160	0	0	0	0	0	0	0	0	0
CR 503	1	100	7	67	5	88	6	87	6
CR 504	7	700	50	469	34	616	44	609	44
CR 505	4	400	29	268	19	352	25	348	25
CR 506	0	0	0	0	0	0	0	0	0
CR 507	1	100	7	67	5	88	6	87	6
CR 508	3	300	21	201	14	264	19	261	19
CR 509 - U.S.160B south to CR 510	0	0	0	0	0	0	0	0	0
CR 510 – CR 222 east to CR 513	1	100	7	67	5	88	6	87	6
CR 516 - U.S.160B south to CR 520	1	100	7	67	5	88	6	87	6
CR 525 – CR 523 east to end	4	400	29	268	19	352	25	348	25
CR 526	0	0	0	0	0	0	0	0	0
CR 527 – CR 526 east to CR 528	0	0	0	0	0	0	0	0	0
CR 527 – CR 528 north to end	33	3,300	236	2,211	158	2,904	207	2,871	205
CR 528	3	300	21	201	14	264	19	261	19
SR 172 Corridor - U.S.160 south to CR 309	0	0	0	0	0	0	0	0	0
SR 3 Corridor	0	0	0	0	0	0	0	0	0
U.S. Highway 160 B Corridor - U.S.160 east to U.S.160	3	300	21	201	14	264	19	261	19

Table 3-134 Projected Alternative 1 CBM Vehicle Trips for Construction Activities by Road Segment

Road Segments	Number of Proposed Wells	Trip Frequency for Light Vehicles[1]	ADT for Light Vehicles	Trip Frequency for Medium Vehicles[1]	ADT for Medium Vehicles	Trip Frequency for Medium Heavy Vehicles[1]	ADT for Medium Heavy Vehicles	Trip Frequency for Heavy Vehicles[1]	ADT for Heavy Vehicles
U.S. Highway 160 Corridor – CR 223 (west end) east to CR 223 (east end)	4	400	29	268	19	352	25	348	25
U.S. Highway 160 Corridor – CR 223 east to CR 501	6	600	43	402	29	528	38	522	37
U.S. Highway 160 Corridor – CR 501 east to Archuleta County line	7	700	50	469	34	616	44	609	44
U.S. Highway 160 Corridor – SR 172 east to CR 223	2	200	14	134	10	176	13	174	12
U.S. Highway 160 Corridor - U.S.550 east to SR 172	4	400	29	268	19	352	25	348	25
U.S. 550/160 Corridor - CR 203 south to Farmington Hill	0	0	0	0	0	0	0	0	0
NOT IN LINK AREA	161	16,100	1,207	10,537	809	13,840	1,062	13,683	1,050
Total	284	28,400		19,000		25,000		24,700	

Notes:

1. Typical Vehicle Weights (lbs) — Light: <6,000 and 6001 to 10,000, Medium: 10,001 to 14,000 and 14,001 to 16,000, Medium heavy: 16,001 to 19,600 and 19,601 to 26,000, Heavy: 26,001 to 33,000 and 33,001 and over

Light trucks account for about 29 percent of the total number of trips by CBM construction vehicles. The costs for road maintenance from light trucks are the same as from deterioration caused by other passenger vehicles. The total vehicle trips by 31,800 light trucks would be spread out over an estimated 5-year construction period for all wells proposed for the Project Area. Light-truck traffic associated with each well would be temporary, occurring over an estimated construction and installation period of 2 weeks.

Heavy truck traffic would account for about 25 percent of the total number of trips by CBM construction vehicles. Heavy truck traffic would result in increased costs for road maintenance because they cause more damage to road surfaces of all types than do automobiles and light trucks. The County Road and Bridge Department indicates that maintenance costs on roads with CBM traffic by heavy trucks have increased because the impact from one combination truck (a truck with three axles or more) is the same as from 1,350 passenger cars. It is anticipated that county road maintenance cost would increase as a result of construction-related truck traffic.

The existing average daily trips for all types of CBM industry vehicles on selected county roads total 72 (Table 3-133). Alternative 1 would increase the CBM traffic on these roads approximately 49 percent, to 102 average daily trips. Because 25 percent of the vehicle trips would be heavy trucks, there would be approximately 26 heavy trucks added to the existing average daily traffic from CBM vehicles. The increase in heavy truck traffic would accelerate deterioration of pavement, requiring the county to schedule pavement repair or replacement more frequently than under existing traffic conditions. The 1997 Federal Highway Cost Allocation Study estimates that the cost per mile for an 80,000-pound combination truck on rural highways is 18.1 cents per mile, which is significantly higher than the 0.1 cents per mile damage caused by passenger vehicles on rural highways.

Some heavy trucks or loads they carry may exceed allowable weight limits for bridges on county roads. These vehicles would require a special permit from the county. The conditional special permit is valid for one-way trips for loads that exceed the maximum limits indicated on the bridge weight limit map, which is on file in the county clerk and recorder's office. Overweight vehicles may also require a transport permit to move or operate on a roadway.

Fees paid to the county from permits contribute to county revenues. Currently, about 32 percent of revenues are spent on roads and bridges, including road maintenance.

Medium- to medium-heavy trucks account for the remaining 46 percent of the total number of CBM construction vehicle trips. The total vehicle trips by medium- to medium-heavy trucks would be spread out over an estimated 5-year construction period. Traffic by medium- to medium-heavy trucks associated with each well would be temporary and would occur over an estimated construction and installation period of 2 weeks.

The La Plata County Code (Chapter 1, General Provisions, Subpart B, Land Use System) includes standards for surface disturbance for oil and gas facilities lo-

cated on lands within the unincorporated area of the County, with the exception of areas under federal or state jurisdiction. Installation of facilities that are accessible by unmaintained roads included in the County system is permitted only if they are improved. In addition, they must be maintained by the applicant to a level the County Engineer deems necessary to allow the traffic to use these roads in accordance with applicable state and county standards.

3.12.3.1.5 BLM Roads

It is anticipated that 4 miles of CBM well access road would be constructed on BLM parcels within the Project Area. The rights of way for the access roads would be 40 feet. Assuming that the entire right of way would be cleared during road construction, approximately 14.5 acres would be disturbed on BLM parcels. No existing roads accommodate vehicles on the affected parcels. There would be no conflict with other traffic on BLM lands.

The La Plata County road network would be used to access CBM facilities and associated roads on BLM land. The potential for traffic conflicts would occur at intersections of BLM access roads with county roads.

There is potential for new roads to provide access for dirt bikes, four-wheelers, ATVs, and snowmobiles in previously roadless areas on BLM lands. BLM lands are accessible only via public roads or across private land, which requires permission of the landowner. BLM lands in the Project Area are isolated parcels surrounded by private lands and are generally not large enough to provide a satisfying recreational experience for motorized and nonmotorized users of the roads and trails.

3.12.3.1.6 National Forest System Roads

The proposed road system was designed around well spacing requirements and topographical considerations. Where well windows are depicted, roads were not located, but it was assumed that each well would result in one-half mile of new road construction to estimate the total disturbance from unmapped roads in this area.

An on-site investigation leading to final road location and design would be conducted by agency personnel during the APD stage for each road and well pad location. This roads analysis assumed that all compressor stations and injection wells would be accessed via an existing or proposed CBM road.

As a condition to the use of BLM/FS roads outside of the leasehold, the operator would be required to obtain a BLM/FS approved Road Use Permit, as applicable. Arterial and collector access roads, in general, are existing roads within the national forest that are currently receiving other, non oil and gas use, including recreation traffic, private land access and other management use. These access roads include, but are not limited to, the Sauls Creek Road, Spring Creek Road, and Fossett Gulch Road. Prior to any oil and gas use, these roads may need to be reconstructed to a double lane, all-weather standard to accommodate the intended use.

A traffic and engineering study will be conducted on these roads to determine whether upgrade or some level of reconstruction is needed prior to use by oil and gas vehicles. The study will be conducted by a registered professional engineer and will assess current and anticipated traffic use including the number, size, weight, and configuration of the vehicle and current road conditions. Design parameters that will be assessed are road width and alignment, drainage, structural strength, including aggregate base and surfacing needs, slope stability, clearing, cattle guards, and fences.

All bridges shall also be assessed to determine weight capacity. The FS would furnish the operator with all available information on roads and bridges that may affect the intended use.

In general, road standards outlined in Appendix A, Section VI, shall be met. However, road width, in some cases, may need to be upgraded to a double lane standard of 24 feet. All costs associated with upgrading of roads and bridges shall be at the expense of the operator.

The proposed road system for Alternative 1 is tabulated on Table 2-1, (in Chapter 2) and depicted on Figure 2–2. There would be differences in the proposed road system under each alternative as tabulated and described on Table 2-1 through Table 2-7. Each of the action alternatives would have the same travel management scheme, meaning the same roads would open to seasonal public use regardless of alternative. The alternatives would differ, however, in the number of miles of road constructed to access CBM well sites and number of miles of road closed to public use.

Alternative 1 would require a network of 88 miles of collocated access roads and pipelines to serve the well pads on NFS lands. Access to the NFS portion of the NSJB CBM Project would be from existing roads including U.S. Highway 160, State Highway 151, La Plata County Roads 525 and 527, and NFSRs 123, 132, 537, 608, 613, 615, 743, and 756. Some existing unimproved NFS roads would require reconstruction, particularly near NFS road 615.

After the proposed roadwork is complete, the densities of the National Forest roads managed as "open to the public" in each management area would not change measurably from the existing open road densities (summarized in Table 3-128). However, the overall road density would increase (Table 3-135). The access roads that would be open to the public are classified as seasonally open under the proposed travel management plan (Figure 3–50). All other roads constructed or upgraded for CBM facility access would be managed as closed to public motorized use, but company employees would utilize the CBM well access roads for maintenance and inspection purposes. Changes to travel management areas in the Project Area are discussed in the Recreation Section 3.11.3.1.1, and the proposed system of open roads is depicted on Figure 3–50.

The proposed road network would open a substantive amount of previously unroaded land to motorized access. Though most new CBM well access roads would be closed to the public, the expanded road system could still lead to increased incidences of illegal activity such as poaching, illegal woodcutting, disturbance of cultural sites, and to wildlife impacts, despite the fact that they would

be monitored for travel management compliance. Road impacts on wildlife are analyzed in detail in Appendix J and Section 3.9. In summary, the expanded road system would result in an increase in watershed impacts (Section 3.6), habitat fragmentation and to a reduction in wildlife habitat effectiveness, even with road closures limiting use to industry personnel for maintenance and inspection purposes only.

Table 3-135 Projected Road Density (existing and proposed) for Management Areas in the National Forest for Alternative 1

	Road Density (miles of road per square mile)		Forest Plan Standard (miles of road per square mile)
Management Area	FS Classified Open	FS Classified Closed/Un classified	Local open Roads
2B	0.39	0.14	0.5 to 1.0
3A	0.83	0.96	No standard
4B	0.19	0.15	0.5 to 1.0
5B	0.34	0.23	0.0 to 0.5
6B	1.36	0.91	0.5 to 1.0

Source: FS 1983

Upon project completion, all roads constructed specifically for the project would be removed, with the exception of those roads that remain open to the public during the duration of the project and those that the Forest Service retains for administrative purposes. The road system open to public use under the proposed travel management plan is depicted in Figure 3–50. Roads that are not needed for further use would be blocked, re-contoured, reclaimed, and vegetated consistent with the requirement of the FS (according to Onshore Oil and Gas Order No. 1, Approval of Operations). Gravel surfaces would be removed. Disturbed areas would be backfilled as needed and graded to the desired configuration. Erosion control features would be installed to stabilize the surface, if necessary. Roads would be revegetated with a seed mixture authorized by the FS and certified as weed free. Commercial seed either would be certified or registered. Seeding and planting would be repeated until satisfactory revegetation is achieved.

3.12.3.2 Alternative 2

Under Alternative 2, county road access to the Project Area would be the same as for Alternative 1; however, there would be a larger number of miles of well access roads (202 miles) constructed on private, BLM and National Forest jurisdictions than are proposed for Alternative 1 (Table 2-3). Maximum development would require more construction and maintenance traffic. There are approximately 75 percent more facilities, which would result in 75 percent more vehicle trips for construction and maintenance that would affect traffic levels on the regional road system within the Project Area. Alternative 2 would have the greatest impact of all the alternatives because it would result in the greatest increases in traffic levels and potentially higher accident rates on public roadways. There

would also be higher levels of road degradation, resulting in the highest road maintenance costs of all the alternatives.

All of the National Forest portion of the Project Area would be roaded to a density of approximately two to 2.5 miles of road/square mile (Figure 2–3). A small portion of the roads would be open to public uses (Figure 3–50), but all access roads would be utilized by industry personnel for maintenance and inspection purposes. Consequently, despite road closures, the resultant road network would increase access to a large portion of previously unroaded area (Section 3.10.3.2 above) and would increase the potential for illegal activities and road use. The expanded road system would also result in watershed impacts (Section 3.6), habitat fragmentation, and reduced habitat effectiveness over most of the HD Mountains (Appendix J and Section 3.9).

3.12.3.3 Alternative 5 — No Action

Alternative 5 would involve constructing 43 miles of road to access private and state mineral estate, mostly in the western Project Area where transportation impacts would be similar to Alternative 1.

In contrast to the western Project Area, the level of impact to county roads that access National Forest in the eastern Project Area would be reduced because of very limited CBM development on National Forest. Approximately 14 wells would be constructed within the National Forest on private mineral estate/federal surface in the Fosset Gulch area. No other wells would be constructed on National Forest, so the road system would be limited in geographic reach to slightly more than the current system that services the HD Mountains. The density of open roads on National Forest would not increase under this alternative. CBM development impacts to county roads maintenance county road traffic and accident potential, watersheds, and wildlife would be minor.

3.12.3.4 Alternative 6

Access to the Project Area from highways and county roads would be the same as for Alternative 1.

The companies would construct 66 miles of well access roads, but few would be open to public use (Figure 3–50). The impacts to the regional road system within the Project Area would be similar to Alternative 1, but the magnitude of traffic impacts and land disturbance from construction of access roads would be reduced.

The projected CBM traffic and traffic related congestion and wear and tear to roads in the western Project Area would be equal to Alternative 1. Overall, there are approximately 38 percent fewer facilities (as compared to Alternative 1), which would result in 38 percent fewer vehicle trips for construction and maintenance that would affect traffic levels on the regional road system within the Project Area.

In the eastern Project Area CBM related traffic on Highway 160 and NFSR 613 to access National Forest development and production would be approximately 40 percent of Alternative 1. On the National Forest, the companies would con-

struct 39 miles of CBM well access road as compared to 90 miles in Alternative 1. The resultant road network would open up previously unroaded area, but not to the extent that Alternatives 1 or 2 would. The roads open to seasonal public use are depicted in Figure 3–50; all other CBM wells would be closed to public motorized use. Nevertheless, despite road closures, the resultant road network would increase access to some previously unroaded areas in the HD Mountains (Section 3.10.3.2), and would increase the potential for illegal activities and road use. The expanded road system would also result in increased watershed impacts (Section 3-6), habitat fragmentation and reduced habitat effectiveness over portions of the HD Mountains, though the impacts would be lower than described for Alternatives 1 or 2 (Appendix J and Section 3-9). A large area of the core of the HD Mountains would remain roadless and unaffected by road construction access and vehicular use (Section 3.10.3.2. and Figure 3–45).

3.12.3.5 Alternative 7

Access to the Project Area from highways and county roads would be the same as for Alternative 1.

Alternative 7 would require 92 miles of new road to access well pads. The impacts to the regional road system within the Project Area are similar to the type of effects described for Alternative 1, but the magnitude of traffic impacts and land disturbance from construction of access roads is slightly reduced. Overall, there are approximately 16 percent fewer facilities, which would result in 16 percent fewer vehicle trips for construction and maintenance that would affect traffic levels and road wear on the regional road system within the Project Area, as compared to Alternative 1.

In the eastern Project Area, CBM related traffic to access National Forest development and production from Highway 160 and NFSR 613 would be approximately 25 percent lower than Alternative 1, resulting in less road construction and commensurately lower road wear and tear.

National Forest road construction would total 64 miles of CBM well access road as compared to 90 miles in Alternative 1. The resultant road network would open up some previously unroaded area, but not to the same extent as Alternatives 1 or 2, particularly in the HD Mountains Roadless Area (Figure 3–42 compared to Figure 3–46 and Section 3.10.3.2). A large core of the HD Mountains would remain roadless and unaffected by road construction and vehicular traffic (Section 3.10.3.2 and Figure 3–45). The roads open to seasonal public use are depicted in Figure 3–50; all other CBM wells would be closed to public motorized use.

The resultant road network would increase the potential for illegal road use and activities. The expanded road system would also result in increased watershed impacts (Section 3.6), habitat fragmentation, and reduced habitat effectiveness over approximately half of the HD Mountains. Overall, however, transportation system impacts would be lower than described for Alternatives 1 or 2 (Appendix J and Section 3.9).

3.12.4 Cumulative Effects

Direct effects to the primary access routes within the Project Area, including State, National Forest, and county roads, would occur as a result of project-related vehicular traffic associated the alternatives and include traffic congestion, accident rates and road damage. Continued CBM development in the Project Area is not expected to significantly impact traffic congestion or accident rates. However, CBM development, especially during construction phases, has the potential to cause road damage and associated resource impacts if proper traffic control and access route design procedures are not implemented.

Traffic rates on county roads that would be most heavily used by gas industry vehicles are expected to increase between 50 and 137 percent between 1998 and 2020, primarily as a result of residential growth on private land in the Project Area. Oil and gas development would contribute to increased traffic on these roads to a much lesser degree than would population growth.

The SUIT study area, which is located south of the Project Area, was evaluated in a separate EIS, cited above, for traffic congestion and accident rates resulting from CBM traffic on roads used by the public in the study area. The SUIT analysis found that the alternatives resulted in no perceivable incremental traffic impacts on residents in the study area. CBM traffic from existing and proposed operations in the SUIT area would not generate additional traffic in the Project Area. CBM traffic in the SUIT study area would not use any of the county roads and highways that would be used under any alternative in the Northern San Juan Basin Project Area. Therefore, there would be no incremental effects to traffic congestion and accident rates from cumulative oil and gas development on individual county roads and highways within the Project Area from SUIT CBM traffic. Cumulative effects would occur primarily from existing and projected traffic within the Project Area.

The greatest increases in traffic volume from cumulative (existing and anticipated) CBM construction and maintenance traffic would occur on segments of CRs 223, 228, 501, 502, 504, 505, and 527, and U.S. Highway 550. With the exception of CR 527, these roads are the same roads used to access existing and future residential development. A significant impact on the volume of traffic would exist if anticipated CBM development were projected to generate 25 percent or more additional daily vehicle trips. Traffic from CBM development would have no perceivable impact if it generates less than 10 percent of additional vehicle daily trips. Table 3-136 summarizes daily trips associated with existing and projected CBM wells under Alternative 1 in the Project Area, and compares the trips with the ADT volume of all vehicle types for 1998 and the projected 2020 ADT for selected roads in La Plata County. The table shows that increases generated by cumulative CBM maintenance traffic are generally less than one-percent, and in one case, 10 percent of additional average daily trips on most of the selected segments of county roads.

The cumulative CBM industry traffic effects would include an increased risk of traffic accidents in proportion to the amount of increased daily traffic for any of the alternatives. The number of traffic accidents has increased on some county roads in areas of existing CBM development. The potential for conflicts with

CBM-related traffic is highest along roads used to access existing and future residential development. Two of these roads (CRs 228 and 501) were identified as high accident locations, as discussed in Section 3.12.2.3. However, rates of traffic accidents would increase because of an increase in the volume of traffic, which is not expected to be significant. The cumulative transportation effects of traffic congestion and accident rates would not be significant for any roadways in the Project Area and would have no perceivable impact on any roadways, with the exception of CR 223, which would experience an increase in daily traffic levels of about 16 percent at the beginning of production activities and about ten-percent over time.

Table 3-136 Cumulative Access Roads for Each Alternative

	Total Length by Alternative (miles)				
Roads	1	2	5	6	7
Existing	191	191	191	191	191
Alternative	116	202	43	66	92
Cumulative	307	393	234	257	283
Increase	62%	107%	23%	34%	48%

Increased degradation of existing roadways may result from any of the alternatives when incremental effects of proposed CBM traffic are added to existing CBM and other traffic. Based on the distribution of the well locations for each alternative, additional wear and tear on county roads and classified open FS roads would likely occur. CBM industry contribution to wear and tear to county and NFS roads would probably be greater that the proportional use described in Table 3-185 because use of medium and heavy trucks by the CBM industry is probably proportionally higher than current heavy truck use of the selected county roads.

Table 3-136 summarizes the cumulative number of CBM access road miles from existing and projected CBM development in the Project Area. The SUIT analysis did not evaluate the increase in the number of access road miles; therefore, the cumulative access road miles shown on Table 3-136 include only cumulative access road miles from CBM development within the Project Area. There would be no increase in the miles of road open to the public on federal, state, and private lands, as all proposed access roads would be closed under all of the alternatives.

3.12.5 Mitigation and Monitoring

This section provides options for mitigating the impacts to traffic and transportation associated with the anticipated CBM development. Unless otherwise stated, the companies would fund the following measures.

The primary impacts identified are a minimal increase in daily traffic and associated small increase in risk of accidents during construction and operation of the CBM facilities. Other impacts include increased wear and tear on National Forest roads and bridges, county roads, and county bridges caused by additional traffic and heavy equipment vehicles during construction of new CBM facilities.

Heavy truck traffic would account for approximately 25-percent of CBM construction vehicle trips. Construction vehicles would damage road surfaces to a greater degree than is indicated by the small increases in overall traffic volume. Heavy truck traffic would result in increased costs for road maintenance because heavy trucks cause more damage to road surfaces relative to automobiles and light trucks.

3.12.5.1 NFS Roads

The following mitigation measures for new access roads constructed on federal lands include:

- Operators conduct maintenance of all access roads authorized through a lease, right-of-way, easement, or road use permit. Construction and maintenance are to comply with landowner requirements or agency standards. Maintenance includes, but is not limited to, blading, cleaning ditches and drainage facilities, controlling noxious weeds, or other requirements as directed by the landowner or agency.
- Construct or install road barriers or signs to discourage public use of well access roads.
- Reclaim access roads following project completion and revegetate in accordance with agency regulations and landowner agreements.
- Mitigate dust by gravelling, or by spraying water or other dust palliatives on roads as needed.

Road construction and use would follow the conditions of approval for road construction and operation presented in Appendix A. The construction, maintenance, and mitigation requirements are all effective, time proven standards for road construction and operation. These measures are utilized Forest Service and BLM wide and have been published in the "Gold Book" titled ***OIL AND GAS Surface Operating Standards for Oil and Gas Exploration and Development***

3.12.5.2 County Roads

Mitigation of county road impacts is accomplished through county road maintenance that is supported through revenues derived from property tax assessments, energy impact assessment grants, and permit fees for overweight/oversized vehicles. The amount of these oil and gas companies' derived revenues is presented in Section 3.15 below — Social and Economic values. Any further regulation would be a matter of state or county regulatory rulemaking.

3.12.6 Conformance to Existing Plans and Policies

The proposed new and reconstructed access roads would be maintained to a level three standard of road maintenance, which is typically utilized for roads that are low speed, single lane with turnouts and of native or aggregate surfacing. For all alternatives, open road density guidelines may be exceeded in Management Area 6B, primarily in the Sauls Creek area. Roads to access well locations would also be constructed in Management Area 5B, which are present in the Spring Creek and Fosset Gulch areas. These roads are not consistent with general direction and

guidelines for Management Area 5B, which allow for new roads within the management area only to meet priority goals outside the management area.

3.12.7 Unavoidable Adverse Effects

Unavoidable adverse effects associated with construction and operation of the road system include resultant soil erosion, potential for mass wasting, and wildlife impacts. These unavoidable adverse effects are presented in the Soils and Wildlife sections of this Chapter, respectively.

3.12.8 Irreversible and Irretrievable Effects

Irreversible or irretrievable commitments of resources are addressed in the Soils and Wildlife Sections, respectively. In terms of commitment of land to roads, the impact would be reversed after project completion in about 30 years. At that time, the vast majority of roads constructed for this project would be obliterated and returned to prior use. The productivity of the reclaimed sites would generally not equal pre-construction condition, however.

3.13 Visual Resources

3.13.1 Issues

Issue 9: The effect of additional CBM development on the Project Area's scenic values.

- Will CBM development exceed the BLM and FS' visual management guidelines?
- How will further CBM development visually alter the landscape when viewed from sensitive viewpoints (highways, roads, trails and residential areas)?
- How will construction and operation of pipelines, power lines, fences, and roads affect visual quality?
- How will the contrast from flaring affect the rural area?
- How will nighttime lighting at compressor stations affect the scenic values of night-sky darkness of the area?

3.13.2 Affected Environment

Most of the Project Area is considered moderately scenic. Because of the varied topography, much of the Project Area is visible from a variety of sensitive viewing areas. Areas that are visible from many locations or at close range are considered the most sensitive to modifications of the landscape.

Public sensitivity to landscape modification is relatively high. Reflecting this sensitivity, current objectives for management of visual resources on public land control the degree of alteration that may be allowed in the landscape. Sensitivity values are based on a combination of visual exposure, viewing distance, and the number of people who view the area.

3.13.2.1 Landscape Character

3.13.2.1.1 Baseline Conditions

The landscape character was identified using:

- The Visual Quality Objectives (VQO) map developed for the Project Area (FS 2003d),
- The Durango 1993 BLM edition topographic map (BLM 1993),
- Aerial photography for the San Juan National Forest map (FS 1994a), and
- Maps of data or vegetation and observations during site reconnaissance.

The variety of landscapes in the Project Area draws people to live, work, and recreate. The western portion of the Project Area is characterized by rolling hills, mesas, plateaus, and hogbacks, interspersed with broad to narrow drainages. The eastern portion of the Project Area, which is mostly National Forest, consists of mountainous terrain mixed with upland hills, rolling uplands, ridges, and narrow valleys, as well as river valleys.

The vegetation varies with location in the Project Area. In the Area's western portion, vegetation ranges from agricultural cropland at lower elevations to desert shrub, desert woodland, mountain shrub, and conifer woodland at the upper elevations. Vegetation in the eastern portion of the Project Area consists primarily of piñon/juniper, oak, and coniferous vegetation. The soils and rock formations also add to the variety of landscapes.

Several waterways are used for recreation and are viewed by residences and motorists. Major waterways in the Project Area consist of the Florida and Los Piños Rivers. The Florida River is located along the eastern edge of Florida Mesa and eventually flows into the Animas River south of the Project Area. The Los Piños River flows north to south, just west of Bayfield. The Piedra River is a major tributary east of the HD Mountains and outside the Project Area.

3.13.2.1.2 Existing Landscape Modifications

Throughout the Project Area, the landscape has been modified by agricultural, residential, commercial, transportation, and oil and gas development. The degree of modification from these land uses varies, depending on location within the Project Area and the types of modifications. Agricultural development causes a break in native vegetation, which creates a visual contrast in color and texture. Residential development generally consists of low-density and rural housing, with a few areas of high density that create a major modification of the landscape. The scenic quality is decreased as a result of the alteration in the landscape. Typically, transportation corridors are primary areas of residential, commercial, and industrial development. The linear effect of roads also alters the character of the landscape, because roads are likely to attract the attention of a viewer with the contrast in color, form, and texture, as well as the activity associated with the corridors.

Oil and gas development has modified the character of the landscape because native vegetation is cleared and industrial-like components are put in place, which can attract attention. These impacts are discussed in the subsection that describes CBM development to date (starting on page 3–412).

3.13.2.1.3 Visual Classification Systems Relevant to the Project Area

All federal, state, and private land in the Project Area were analyzed using the FS' Visual Management System (VMS), described below. The BLM generally inventories and manages visual resources with the BLM Visual Resource Management (VRM) system. The VRM is similar to the FS VMS in that both use fundamental principles of design (form, line, color, and texture) to quantify resource values by inventory, set objectives, and evaluate impacts on a landscape. However, because non-national forest land in the Project Area has not been inventoried for visual resources, and to maintain consistency in the analysis of the visual resource process, the FS system was expanded to include BLM, private, and State land. The process was used to assess the existing visual resource and analyze potential impacts on characteristic landscapes for the entire Project Area. However, the FS and BLM apply management objectives associated with each FS VMS classification to federal land only.

FS VQOs describe the degree of acceptable alteration of the natural landscape, based on the importance of scenic values as indicated by the VMS process. VQOs are based on diversity of natural features (variety class) and the public's concern for scenic quality (sensitivity levels). These objectives include Preservation, Retention, Partial Retention, Modification, and Maximum Modification.

Three of the five possible VQOs were mapped in the Project Area as a result of the process: Retention, Partial Retention, and Modification. The Retention VQO provides for management activities that are not visually evident and that repeat only the form, line, color, and texture that are frequently found in the characteristic landscape. The Partial Retention VQO allows for activities that remain visually subordinate to the characteristic landscape. The Modification VQO allows for activities that may visually dominate the original characteristic landscape. These activities must, however, borrow from naturally established form, line, color, or texture, so that the visual characteristics are like the surrounding area.

Visual Objectives within the Project Area

The Project Area's VQOs were developed and mapped using the process outlined in Volume 2, Chapter 1, Forest Service, Department of Agriculture Handbook 462, *The Visual Management System* (FS 1974). Variety classes were established using previous mapping of the area for past management activities, as well as the 1983 SJNF LRMP. The Project Area was inventoried in the field during the summer of 2002 to delineate the three variety classes. The sensitivity levels of all travel ways and use areas had been rated in 1992.

The analysis assumed that landowners would exhibit major concern for aesthetics and the scenic quality of their land and the land around them. This assumption resulted in high sensitivity levels. As a result, much of the private land in the western portion of the Project Area has been assigned a VQO of Retention. The federal land in the eastern portion of the Project Area generally was rated with lower sensitivity levels, which resulted in the VQOs of Partial Retention and Modification. Figure 3–51 shows the distribution of the Retention, Partial Retention, and Modification VQOs mapped in the Project Area. Table 3-137 shows the distribution of VQOs by land ownership.

Table 3-137 Distribution of Visual Quality Objective Classifications by Surface Ownership

	Areal Extent of VQO by Ownership				
VQO Classification	BLM (acres)	NF (acres)	State (acres)	Private (acres)	Total (acres)
Retention	3,003	7,950	3,209	48,730	62,892
Partial Retention	2,122	22,663	1,249	16,042	42,076
Modification	1,548	18,770	4	57	20,379
Total	6,673	49,383	4,462	64,829	125,347

3.13.2.1.4 Impacts of CBM Development to Date

Oil and gas development in the Project Area is not evenly distributed among the three VQOs. About 4 percent of existing development is in the areas mapped with the Modification VQO. Another 24 percent is in areas mapped with the Par-

tial Retention VQO. Most (72 percent) of the existing oil and gas development occurs in areas mapped with the Retention VQO.

Most of the development in areas classified for Modification meets the objectives of the classification because it accommodates changes that visually dominate the original characteristic landscape. Facilities in the foreground, middle ground, and background perspectives or distance zones all meet this objective.

Some, but not all, of the oil and gas development in areas classified as Partial Retention is consistent with that VQO, which accommodates activities that are visually subordinate to the characteristic landscape. Consistency with the objective of Partial Retention primarily depends on the distance zone where the facility is located. Based on field observations in the Project Area, facilities located in the background and middle ground distance zones are typically subordinate or unnoticed and meet the objective of Partial Retention, but facilities in visually exposed areas in the foreground often do not.

Most of the oil and gas development in the foreground distance zone does not meet the objective of Retention, which accommodates modifications that are not visually evident and only repeat the line, form, color, and texture in the landscape, because it is visually prominent. The Retention objective is generally met in the middle ground and background distance zones, because these facilities are unnoticed or subordinate to the landscape.

In many cases, the oil and gas development in the Project Area has achieved the applicable VQOs using visual-mitigation techniques, which can substantially reduce the visual prominence of many facilities and related disturbance. Based on observations of oil and gas development in the Project Area, well pads typically have been recontoured and reclaimed so that the form, line, color, and texture of the characteristic landscape are repeated. The locations of the pads have been bermed and revegetated immediately, to reduce the duration of visual impacts. In most instances, facilities have been painted to meet BLM and FS specifications for color associated with soils and vegetation.

The linear features associated with access roads and pipelines that are routed cross-country make visual objectives more difficult to meet than do the locations of surface well pads. Often, the form, line, color, and texture are, for the most part, repeated, but contrast with vegetation, and the linear nature may remain evident. Typically, roads have been constructed to blend with the topography, and cuts and fills are revegetated.

3.13.2.2 Sensitivity of Landscape Viewshed

3.13.2.2.1 Baseline Conditions

"Sensitivity of landscape viewshed" is the extent that features are noticeable or apparent in the landscape. Distance and screening profiled by topography are two aspects considered in evaluating the sensitivity of the landscape viewshed.

Sensitive viewing areas were identified to facilitate the analysis of sensitivity of the landscape viewshed. As shown in Figure 3–52, these viewing areas were primarily in three representative land use-categories: recreation/open space, trans-

portation corridors, and residential areas. These three land-use categories represent the uses of public and private land in the Project Area and contain most of the viewers who would be concerned about the scenic quality of a landscape. Land uses in the remainder of the Project Area consist of agriculture, which includes sparsely scattered rural residences, state land that is not designated for specific land uses, and isolated parcels of BLM land. A small number of viewers in these areas are concerned about the scenic quality of the landscape.

In coordination with staff of the BLM, the FS, and La Plata County, the sensitive residential viewing areas shown in Figure 3–52 were identified as representative "visual receptors" (locations where humans "receive" the impacts, such as at a residence) in each land-use category. Polygons (circles) that depict representative land-use areas were digitized (mapped) on a topographical map for inclusion in Figure 3–52. The polygons represent areas where the majority of residents or visitors to the Project Area would view existing oil and gas development.

Sensitive points delineated in the Project Area included a variety of residential areas. These viewing areas were identified based on the subdivisions in La Plata County.

Fewer travel routes and recreational areas were identified as sensitive viewpoints. Travel routes identified as sensitive viewpoints include U.S. Highway 160; La Plata CRs 228, 172, and 521; and NFSRs 537, 613, and 608. Recreational areas so identified include the Grandview Ridge Trails on BLM land and the HD Mountains on National Forest land.

Photographs of gas facilities located in each land-use category were taken from the sensitive viewing areas shown in Figure 3–52. The 17 photographs in Figure 3–53 through Figure 3–69 show the appearance of gas production facilities and other industrial development of low- and high-density residential subdivisions, recreation areas, and roads. The photographs show oil and gas facilities in the foreground and middle ground distance zones. The foreground includes distances ranging up to 0.5 mile from the viewer. Middle ground includes distances from 0.5 to 3 to 5 miles from the viewer. According to the viewshed analysis from sensitive viewpoints, a large portion of the Project Area is visible from these locations, as shown in Figure 3–70. The photographs represent the appearance of typical CBM well development that occurs in these land uses throughout the Project Area.

3.13.2.2.2 CBM Development to Date — Sensitivity and Frequency of Existing Well Development and Associated Facilities

Existing oil and gas development was assessed based on photographs of the foreground, middle ground, and background distance zones from sensitive viewing areas in three land-use categories: recreation/open space, transportation corridors, and residential, as shown in Figure 3–53 through Figure 3–69. In addition to the visible components of the equipment, construction-related dust is visible during well construction and generated by traffic related to oil and gas on unpaved roads.

For this analysis, the existing visual impact of oil and gas development includes various components, such as:

- Well heads
- Separators
- Meter house
- Pump jacks
- Dehydrators
- Condensate tanks
- On-site water storage tanks
- Uncovered pits for produced water
- Covered pits for produced water
- Cathodic protection wells
- Water injection well facilities
- Compressor stations
- Access roads
- Gathering pipelines
- Pipelines and well pads
- Utility lines
- Fences and signs

Visual Impacts of Well Components and Compressors

Existing visual modification of the Project Area has occurred from well facilities described in the preceding list of components in the foreground, middle ground, and background distance zones, as viewed from sensitive viewing areas. The photographs show that the degree of impact on viewers at any of the sensitive viewing areas from existing facilities depends on the availability of natural screening in the surrounding landscape, as well as on the distance zones. It was not feasible to obtain photographs in all land-use categories in the middle ground and background for most of the existing facilities, because topography and vegetation blocked views from many sensitive viewpoints.

Most of the visual impacts occur in foreground views up to 0.5 mile from viewers. The facilities are readily visible to an observer at nearby residences, recreational areas, highways, and county roads. Facilities such as meter houses, pump jacks, condensate tanks, on-site storage tanks, and covered pits for produced water, are prominent in the foreground, as shown in Table 3-138.

The table also lists facilities that are subordinate to the landscape in foreground views because they have a lower profile, making them visible primarily to viewpoints that are higher in elevation. These facilities, which include covered and uncovered pits for produced water, occur sporadically throughout the Project Area.

Table 3-138 Visual Characteristics of Existing Well Development

Well Facility (CBM and Conventional)	Frequency of Occurrence[1]	Foreground (0–0.50 miles)[2]	Middle Ground (0.50–3 to 5 miles)[2]	Background (middle ground to infinity)[2]
Well head	Common	P	U	U
Separator	Common	P	U	U
Meter house	Common	P	U	U
Pump jack (CBM)	Moderate	P	U	U
Dehydrator	Sporadic	P	U	U
Condensate tank	Sporadic	P	S	U
On-site water storage tanks	Moderate	P	S	U
Uncovered pit for produced water	Sporadic	S	U	U
Covered pit for produced water	Sporadic	S	S	U
Cathodic protection well	Sporadic	S	U	U
Support facilities				
Water injection well facilities	Sporadic	P	P	S
Compressor station/gas plant	Sporadic	P	P	S
Linear elements				
Access roads	Common	P	P	S
Gathering pipeline	Common	P	P	S
Transmission pipeline	Common	P	P	S
Well pad	Common	P	S/P[3]	U/S[4]

Notes:
1. Sporadic occurrence = very few structures; Moderate occurrence = found with only one type of well, optional components of well; Common occurrence = widespread, common distribution of wells.
2. P= prominent – dominates surrounding setting; S = subordinate – begins to attract attention, U= unnoticed – does not attract attention.
3. S if partially reclaimed, P if not partially reclaimed.
4. U if partially reclaimed, S if not partially reclaimed.

The contrast in color, line, and form of prominent facilities can be blended to some degree when it is appropriately mitigated (through paint, reclamation, or siting, for example) with the features of the existing landscape. Figure 3–53, Figure 3–54, Figure 3–55, Figure 3–56, and Figure 3–57 show well facilities that have been sited so that the existing vegetation provides a backdrop as seen from sensitive viewpoints. These facilities have been painted colors that harmonize with the existing vegetation, eliminating color contrasts and reducing the contrast of the angular, geometric forms of the facilities with the surrounding natural environment.

Well facilities in foreground views where there is no natural vegetative or topographic screening are more noticeable to viewers, as shown in Figure 3–58 The pump jack in the photograph is situated so that the existing vegetation was not used to screen the facility or provide a backdrop from portions of CR 228. As a result, the pump jack is easily seen from portions of CR 228, because of its strong contrasts in color and geometric form with the surrounding light colors of the landscape.

In Figure 3–59, the pump jack is silhouetted against the backdrop because it is larger than the surrounding vegetation, and the angular lines appear prominent against the homogenous textures of the backdrop terrain.

Figure 3–60 shows an approved well site where the facilities have not yet been installed. Once the facilities have been installed, they will present strong con-

trasts with the surrounding landscape, because of the lack of any natural screening.

In the middle ground distance zone, the geometric forms of wellhead facilities are visible but difficult to discern when they are mitigated to minimize contrasts in color. The wellhead facilities in the middle ground distance zones shown in Figure 3–61, Figure 3–62, Figure 3–63, Figure 3–64, and Figure 3–65 have been painted to harmonize with the surrounding vegetation. This paint eliminates contrasts in color and reduces the contrast of the angular, geometric forms of the facilities with the surrounding natural environment.

Existing oil and gas facilities are generally not visible in the background, which includes developments more than 3 to 5 miles from the viewer. Table 3-138 shows that most facilities in background distance zones do not attract the attention of viewers. At these distances, the scale of the facilities is small, relative to the surrounding landscape. Therefore, the forms, lines, and colors of the facilities are indistinct and blend into the landscape.

Some well pads and linear components such as access roads and pipeline clearings are subordinate to the landscape because of their small scale, relative to landscape elements in foreground and middle ground distance zones; however, sharp contrasts between cleared areas and surrounding dense vegetation may be visible in background distance zones before the sites are reclaimed. When they are appropriately mitigated through reclamation or siting the facilities to use the existing terrain or vegetation for screening, they are generally unnoticed by the casual observer in the background views.

Although support facilities such as water injection wells and compressor stations occur less frequently than wells, often they are more noticeable to the casual observer, because of their size. The six injection wells and six compressor stations within the Project Area can be up to 25 feet tall and 15 feet wide. These facilities can be prominent in the near-middle ground distance of about 0.5 mile, although they are generally subordinate to the landscape in the 1- to 5-mile distances of the middle ground zone.

Table 3-138 shows that these facilities occur sporadically in the Project Area. Both types of facilities are prominent in foreground views, are easily visible in middle ground views, and are often sporadically visible in background views. The compressor station in Figure 3–66 is visible to viewers at a distance of 1 mile; as seen from the highway; however, the compressor repeats the lines and forms of other buildings in the viewshed and cannot be identified as a CBM production facility.

Visual Impacts of Linear Features and Well Pads

Development of linear facilities, such as oil and gas pipelines and roads, can involve clearing dense vegetation and construction on steep slopes. Access roads and well pads present an obvious contrast in color with the surrounding vegetation, as shown in Figure 3–53, Figure 3–55, and Figure 3–67. These cleared areas are typically prominent in the foreground, middle ground, and background views.

Because of the low profile of pipeline clearings and roads, the contrasts of color and the linear form with the landscape are easily screened with surrounding vegetation and topography in middle ground and background views. Generally, linear features are more likely to attract attention when the observer is at a higher vantage point (for example, in rolling hills) rather than on flat landscapes, where the observer is parallel with the activity, and views are easily screened. Typically, roads make up a considerable amount of the disturbance associated with oil and gas facilities.

A well pad will tend to be more sensitive to the viewer immediately after construction, because of the amount of exposed surface. The sensitivity will likely decrease as the disturbed surface begins to blend in color, form, and texture when interim reclamation (recontouring of slopes and seeding) occurs. Well pads and access roads are the most obvious feature of CBM development in the middle ground distance zone, as shown in Figure 3–63 and Figure 3–68 and in the foreground distance zone (Figure 3–69).

Well pads and roads are visible as light brownish-gray, geometric clearings with straight, linear edges that obviously contrast with the surrounding vegetation. Well pads that are partially reclaimed are subordinate in the middle ground and unnoticed in the background, as shown in Table 3-138. Conversely, well pads that are not reclaimed (exposed cuts and fills) are generally prominent in the middle ground and subordinate in the background views.

Sensitivity to Existing Flaring and Compressor Lighting

Other elements that increase sensitivity include activities or components of the facility that result in lighting contrasts. These activities include flaring and lighting from compressor stations. The contrasts from these activities are a result of increased sensitivity at night and are more likely to be viewed in middle ground and background views, more so than during the day.

Flaring associated with well testing, results in a flame that can be noticeable to the casual observer in many distance zones, depending on the terrain. Flaring is a common practice that occurs only when the well is being developed. The activity is commonly visible in most distance zones in rural, agricultural, and undeveloped land during the evening (assuming they are not screened by topography, structures, or vegetation), because of the sharp contrast of the flame. During the day, this activity would likely be viewed only in the immediate foreground and foreground distance zones. Flaring draws the attention of a viewer in the middle ground and background distances in the evening, when the contrast of fire against the dark of night is stark.

Flaring does not usually create smoke or plumes that would be noticeable from background distances. The increased visual sensitivity to flaring is more often a result of the perceived hazard associated with fire, as opposed to the decrease in visual quality. It is estimated that only one to three wells would be flaring at any one time in the Project Area. Flaring is a short-term effect that typically lasts 3 to 5 days at each new well site.

Nighttime lighting of compressor stations also results in increased viewshed sensitivity. Permanent nighttime yard lighting is typically installed for safety and

security to employees, or to protect the public and prevent tampering with the station by the public. Typically, this lighting consists of low-pressure sodium vapor fixtures arranged around the site so that the equipment can be safely operated during darkness.

The lighting systems at the compressor locations are light sensitive and automatically turn on in the evening. This lighting has been arranged to reflect away from any nearby properties and from the vision of passing motorists or recreationists. Of the six existing compressors in the Project Area, five are in the western portion, where most of the current residential development exists. Based on the level of residential development in this portion of the Project Area, lighting from these facilities may not draw the attention of casual observers.

3.13.3 Environmental Consequences

The project's visual impact depends on the amount of visual contrast it creates relative to the existing characteristics of the landscape. Short-term impacts would occur where construction-related equipment, activities, and dust would be visible to observers. Long-term impacts would occur when vegetation is removed; the landscape is altered by construction of CBM well pads and roads; and facilities and equipment, such as wellheads and compressor stations, are installed. Vegetation removal, alteration of the landscape, and installation of equipment and facilities would introduce changes in the line, form, color, and texture of the landscape.

The types of visual impacts are generally similar for each alternative, but are magnified in alternatives that involve more wells and are not as evident in alternatives with fewer wells. In addition, some alternatives would exclude CBM development from portions of the Project Area. As a result, visual impacts would not occur in those areas, under those alternatives. The following discussion describes visual impacts as they relate to the issues raised during scoping that would occur with implementation of the alternatives.

3.13.3.1 Visual Impacts and Conformance with BLM and FS Visual Management Systems

A concern raised during scoping was whether additional development of CBM would conform to the policies and objectives of the BLM and FS visual management systems. The analysis of each alternative below addresses visual impacts and this conformance issue. Because the entire Project Area was inventoried using the FS VQO system, visual impacts were assessed based on conformance with the objectives of the FS visual management system, and not the BLM VRM classification system.

3.13.3.1.1 Alternative 1 — Proposed Action

Long-term impacts from Alternative 1 would result from the addition of the wells and access roads to the landscape and the permanent disturbance of land that would be used for associated facilities, such as gathering lines, well service roads, and access roads. The most visible component of the proposed facilities

would be the pumping units at each well site. Gas-gathering and water pipelines would be buried adjacent to rights-of-way for existing and new roads.

Alternative 1 would impact 660 acres, or 0.5 percent of the Project Area. Some 284 wells on 261 pads, one water disposal well, and 13 compressors would be developed in the Project Area. About 60 percent of these facilities would be on federal land. A total of 118 miles of new road would be developed, with most of the new roads (93 miles) developed on federal land. Impacts would be distributed fairly equally among the three VQO classifications in the Project Area (Table 3-139).

Table 3-139 Distribution of Impacts of Each Alternative by Visual Quality Objective

	Disturbance[1,2] by Alternative				
Visual Quality Objective	1 (acres)	2 (acres)	5 (acres)	6 (acres)	7 (acres)
Project Area					
Retention	209	386	150	173	201
Partial Retention	216	458	60	144	164
Modification	235	306	48	105	174
Total[3]	660	1,150	258	422	540
National Forest					
Retention	59	103	6	29	51
Partial Retention	163	336	17	92	111
Modification	233	299	46	103	172
Total[3]	455	738	69	227	334
BLM					
Retention	20	40	9	18	20
Partial Retention	21	45	7	20	21
Modification	2	6	0	2	2
Total[3]	43	91	16	40	43

Note:

1. Includes all wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, State, and private lands.
2. Does not include facilities at undetermined locations or located outside the Project Area.
3. Totals may not match precisely with values obtained by adding unit numbers based on rounding conventions.

During the 10- to 12-day construction period, the presence of heavy equipment and dust generated by construction and traffic would detract from the visual quality of the landscape at each well location. These actions could conflict with residential and recreational uses because they would be visually and audibly intrusive. Night lighting would also be visible during this period, because drilling occurs on a 24-hour basis. Visual impacts would be greater for well locations near residential areas, along roads, and in open areas that are not screened by topography or vegetation. Construction would be spread over the 5-year construction phase.

After construction is complete, well pads, new access roads, and pipeline and utility trenches would all appear as visible alterations of the landscape. Exposed soils and rock would replace landscapes that had previously been covered with natural appearing vegetation. These disturbed locations would present a visible

contrast to the observer for a period of several months to several years. The duration of this impact would depend on the success of revegetation.

The addition of wells and associated access roads would result in a mixed rural and industrial landscape. Development in the western portion of the Project Area would incrementally alter an already modified landscape character (changed by residential, commercial, agricultural, and gas well development). The components with the highest potential to affect the visual character of the area adversely are the well pad clearings, pumping units, access roads, and pipelines. Operation of the proposed facilities would introduce new elements of form, line, color, and texture into the landscape and would essentially dominate foreground views. They would be visible in middle ground and background views in flat areas that are less vegetated.

There would be 118 miles of proposed access roads and gathering lines in the Project Area (93 on federal jurisdiction). More viewers would observe the visual impacts of road construction in the western Project Area because of the greater residential density. Most of the proposed roads in the western portion of the Project Area would be relatively short, because the existing network of local and oil and gas roads can be accessed for proposed development. The topography is relatively flat in the area and would not result in large cuts and fills, which often attract attention until they are reclaimed. Exposed earth associated with these roads would visually contrast with adjacent, vegetated surfaces in terms of line and color over the life of the project.

Each compressor station would be lighted at night for safety. Each hooded light would be mounted on a pole or building and would be oriented downward to illuminate the facility. This type of lighting would minimize the night shine from the facility. However, the compressors nearest to the residential areas would be visible at night.

When abandoned, the facilities would be removed and the wells plugged. The entire pad would be contoured to blend with the existing topography if it requires regrading and reseeding. The visual disturbances from construction of well pads, roads, facilities, and pipelines vary, depending on the topography, adjacent vegetation, soil types, and nutrient contents that ultimately control the level of successful reclamation. These changes to the landscape in form, line, color, and texture would remain for an undetermined period.

As described in Table 3-138 and illustrated in Figure 3–52, visual contrasts associated with CBM structures and facilities would be most prominent in foreground views. In the middle ground, CBM facilities generally would be subordinate or unnoticeable to the observer, especially with mitigation measures such as painting, feathering graded surfaces, and generally situating wells in areas that are screened by topography and vegetation. CBM-related facilities, with the exception of access roads, generally create very little visual contrast in background views.

Areas Classified as Retention

Table 3-140 summarizes the area of surface disturbance by sensitive viewpoint, distance zone, and VQO. Approximately 260 acres of disturbance would occur in

the foreground view of sensitive viewpoints in areas assigned the Retention VQO, under Alternative 1. Retention guidelines suggest that activities may only repeat the form, line, color, and texture that are frequently found in the characteristic landscape. The objectives of the Retention VQO would be met if mitigation measures were used to maintain the existing character of the landscape and not attract the attention of the casual observer. Mitigation measures must repeat the basic elements of form, line, color, and texture found in the natural features of the landscape within the foreground distance zone to achieve this objective. Successful mitigation in the foreground distance zone would include locating facilities to use the terrain and vegetation to screen them from sensitive viewing areas. The Retention objectives would not be met for facilities where these measures cannot be implemented. These facilities are most likely to be located on National Forest lands near residential areas, roads, and important recreational areas, because these areas would be within the viewshed of a relatively high number of people who are sensitive to changes in the landscape.

Approximately 215 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Retention VQO under Alternative 1 (Table 3-140). Based on field observations, the impacts would be minimal from virtually all CBM-related development that would occur in the background view of sensitive viewpoints, because the facilities are too small to be visible at distances of more than 3 miles. Some CBM facilities would remain visually subordinate to the characteristic landscape where they are sited in the middle ground view of sensitive viewpoints in areas assigned the Retention VQO. Others, however, may result in changes to the landscape that is more noticeable. The Retention VQO would be met for most facilities in the middle ground view of sensitive viewpoints because mitigation measures would maintain the existing landscape, and facilities would not be evident to the casual viewer. Facilities that result in strong color contrasts between well pads and roads after mitigation with surrounding vegetation as seen from sensitive viewpoints would not meet the Retention VQO, because these contrasts are easily visible to the casual viewer.

Areas Classified as Partial Retention

Approximately 175 acres of disturbance would occur in the foreground view of sensitive viewpoints in Partial Retention areas (Table 3-140). The VQO for facilities on Partial Retention lands would be met if adverse visual effects are minimized through careful location of facilities, minimal disturbance of the site, and painting of facilities so that they harmonize with the colors of the surrounding landscape. If the visual impacts cannot be mitigated through such measures, however, the Partial Retention VQO would not be met because the facilities would be visually evident to the observer and would not be subordinate to the characteristic landscape, as required to meet the VQO.

Table 3-140 Distribution of Disturbance by Sensitive Viewpoint, Alternative, and Visual Quality Objective

	Residential Areas[1]			Roads[1]			Recreation[1]		
Alternative and VQO	Foreground[2] (acres)	Middle ground[2] (acres)	Background[2] (acres)	Foreground (acres)	Middle ground (acres)	Background (acres)	Foreground (acres)	Middle ground (acres)	Background (acres)
Project Area									
Alternative 1									
Retention	81	0	60	76	120	13	56	`95	51
Partial Retention	29	54	132	21	157	38	125	54	29
Modification	3	1	231	23	167	45	123	99	13
Alternative 2									
Retention	115	168	103	124	229	34	98	215	67
Partial Retention	40	154	265	43	364	52	259	136	56
Modification	1	12	292	28	220	57	160	127	17
Alternative 5									
Retention	73	53	24	63	82	5	24	72	48
Partial Retention	22	21	17	8	41	12	12	20	20
Modification	2	0	46	1	33	13	6	39	2
Alternative 6									
Retention	81	64	29	76	92	5	37	77	51
Partial Retention	29	48	66	28	90	26	60	48	24
Modification	4	1	100	21	64	20	15	83	5
Alternative 7									
Retention	81	63	57	76	113	12	49	95	51
Partial Retention	29	50	85	22	114	29	74	52	29
Modification	3	1	170	25	118	31	62	96	13
National Forest									
Alternative 1									
Retention	5	0	38	12	41	6	28	28	0
Partial Retention	1	34	128	18	115	31	113	39	4
Modification	1	1	231	23	165	45	123	99	11
Alternative 2									
Retention	5	42	56	12	72	19	40	60	0
Partial Retention	1	82	254	38	263	36	231	89	9
Modification	1	6	292	28	214	57	154	127	17
Alternative 5									
Retention	1	0	5	2	2	1	0	3	0
Partial Retention	1	2	14	6	7	5	0	9	0
Modification	0	0	46	1	1	13	6	39	0
Alternative 6									
Retention	6	13	10	13	15	1	12	12	0
Partial Retention	2	28	63	25	48	19	48	33	0
Modification	2	1	100	21	62	20	15	83	3

Table 3-140 Distribution of Disturbance by Sensitive Viewpoint, Alternative, and Visual Quality Objective

	Residential Areas[1]			Roads[1]			Recreation[1]		
Alternative and VQO	Foreground[2] (acres)	Middle ground[2] (acres)	Background[2] (acres)	Foreground (acres)	Middle ground (acres)	Background (acres)	Foreground (acres)	Middle ground (acres)	Background (acres)
Alternative 7									
Retention	5	12	35	12	34	5	21	28	0
Partial Retention	1	29	81	19	71	22	62	38	4
Modification	1	1	170	25	116	31	63	96	11
BLM									
Alternative 1									
Retention	16	0	0	9	11	0	2	6	13
Partial Retention	19	2	0	3	17	2	0	6	15
Modification	2	0	0	0	2	0	0	0	2
Alternative 2									
Retention	18	22	0	13	28	0	13	13	14
Partial Retention	19	26	0	30	35	7	5	17	23
Modification	0	6	0	4	6	0	6	0	0
Alternative 5									
Retention	5	4	0	4	5	0	2	4	4
Partial Retention	7	0	0	2	4	2	0	2	5
Modification	0	0	0	0	0	0	0	0	0
Alternative 6									
Retention	14	4	0	9	9	0	2	4	13
Partial Retention	18	2	0	3	16	2	0	6	14
Modification	2	0	0	0	2	0	0	0	2
Alternative 7									
Retention	16	4	0	9	11	0	2	6	13
Partial Retention	19	2	0	3	17	2	0	6	15
Modification	2	0	0	0	2	0	0	0	2

Note:
1. Disturbance includes all wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, state, and private lands.
2. Foreground = 0.0 – 0.5 mile, Middle ground = 0.5 – 3.0 miles, Background = 3.0 miles – infinity

Approximately 265 acres of project-related disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Partial Retention VQO under this alternative (Table 3-140). CBM facilities sited in the middle ground views in Partial Retention areas would be visually subordinate to the characteristic landscape or would be unnoticeable in the middle ground view. These visual impacts would be rated moderate to low, based on the observed effectiveness of visual-mitigation measures in reducing the severity of the visual contrast created by project facilities in middle ground views. The VQO for Partial Retention would be met for facilities located in middle ground views seen from sensitive viewpoints.

Based on field observations, the impacts on observers would be minimal from virtually all CBM-related development that would occur in the background view of sensitive viewpoints because the facilities are generally too small to be seen at distances of more than 3 miles. The VQO objectives for Partial Retention would be met for facilities located in background distance zones as viewed from sensitive viewpoints.

Areas Classified as Modification

Nearly 705 acres of disturbance from proposed facilities would be on lands managed with the Modification VQO (Table 3-140). Under the Modification VQO, management activities may visually dominate the original characteristic landscape. However, alterations to vegetation and land form must borrow from naturally established form, line, color, or texture so completely and at such a scale that its visual characteristics are those of natural occurrences within the surrounding area or character type. NFS objectives for facilities on Modification lands would be met if every attempt were made to minimize adverse visual effects through careful location of facilities, minimal disturbance of the site, and painting facilities so they harmonize with the colors of the surrounding landscape. The Modification VQO would be met in all distance zones, because mitigation would borrow from the surrounding natural landscape.

3.13.3.1.2 Alternative 2

Alternative 2 would entail more intensive CBM development than Alternative 1 — particularly near the Fruitland outcrop and on the eastern side of the Project Area. Alternative 2 would involve constructing 529 CBM facilities on federal, state, and private lands. In addition, Alternative 2 would require 202 miles of road construction, slightly less than twice the miles proposed for Alternative 1. The additional wells and roads constructed under Alternative 2 would contribute to a significant increase in visual impacts across the Project Area.

Table 3-139 summarizes acreages that would be affected by Alternative 2 in each VQO classification area. Table 3-140 identifies the distribution of visual impacts by sensitive viewpoint, distance zone, and VQO for this alternative.

About 336 acres of disturbance would occur in the foreground view of sensitive viewpoints assigned the Retention VQO, and 342 acres of disturbance would occur in the foreground of sensitive viewpoints assigned the Partial Retention VQO (Table 3-140). Furthermore, approximately 613 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Retention

VQO, and 653 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Partial Retention VQO under this alternative (Table 3-140). Most visual impact would occur in these area classifications.

Nearly 55 percent of the CBM facilities would be on NFS land, the majority of which would be on land managed with Retention and Partial Retention VQOs. There is considerably more disturbance from facilities in the foreground of views from sensitive areas than in Alternative 1, so it is likely that a greater number of facilities would not meet the Retention VQO. Similarly, a larger number of facilities under this alternative would not be able to meet the Partial Retention objectives than under Alternative 1, as more facility construction is proposed for Alternative 2. The objectives for the Modification VQO would be met for facilities in all distances zones with implementation of mitigation measures.

3.13.3.1.3 Alternative 5 — No Action

Alternative 5 would result in construction of 121 CBM facilities and 43 miles of road located on federal (split estate), state, and private land, resulting in a smaller number of facilities that affect the visual quality of the Project Area than under Alternative 1. Visual impacts would be lower than under Alternative 1 on NFS and BLM lands, the same on state land, and slightly higher on private land. Alternative 5 would have the least visual impact on federal land among the alternatives. Visual impacts on state and private land would be similar to the effects described for Alternative 1.

Table 3-139 summarizes acreages that would be affected by Alternative 5 in each VQO classification area. Table 3-140 identifies the distribution of visual impacts by sensitive viewpoint, distance zone, and VQO for this alternative.

Alternative 5 would have the least impact among the alternatives on the foreground and middle ground views of sensitive viewpoints in the Retention and Partial Retention VQOs. There would be about 161 acres of disturbance in the foreground view of sensitive viewpoints assigned the Retention VQO and 42 acres of disturbance in the foreground view of sensitive viewpoints assigned the Partial Retention VQO (Table 3-140). Similarly, about 208 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Retention VQO and 82 acres of disturbance in the middle ground view of sensitive viewpoints in areas assigned the Partial Retention VQO under this alternative (Table 3-140).

The long-term disturbance of NFS land in each VQO class is expected to be less than Alternative 1, because there would be a smaller number of CBM facilities and miles of road constructed on NFS land. There is considerably less disturbance from facilities in the foreground of views from sensitive areas than in Alternative 1, so it is likely that a smaller number of facilities would not meet the Retention VQO. Facilities in the middle ground and background views would meet Partial Retention objectives with implementation of mitigation measures. The number of facilities under this alternative that would not be able to meet Partial Retention objectives would be smaller than under Alternative 1, because less CBM developments is proposed for Alternative 5. The objectives for the Modifi-

cation VQO would be met for facilities in all distances zones with implementation of mitigation measures.

3.13.3.1.4 Alternative 6

Alternative 6 would preclude CBM development in the HD Mountains Inventoried Roadless Area but would result in the same CBM development in the rest of the Project Area as was described for Alternative 1. There would be 187 CBM facilities and 66 miles of road located on federal, state, and private land, resulting in a smaller number of facilities that affect the visual quality of the Project Area, particularly in the HD Mountains.

Two wells would be located within the HD Mountains Inventoried Roadless Area near the Roadless Area boundary. No other proposed facilities are within the HD Mountains Inventoried Roadless Area. Therefore, a significant portion (more than 20,000 acres) of the National Forest portion of the Project Area would remain undeveloped and not visually impacted by CBM development. Table 3-139 summarizes acreages that would be affected by Alternative 6 in each VQO classification area. Table 3-140 identifies the distribution of visual impacts by sensitive viewpoint, distance zone, and VQO. Alternative 6 would impact the foreground and middle ground views of sensitive viewpoints in the Retention and Partial Retention VQOs to a lesser degree than would Alternatives 1, 2, and 7, but would result in a greater impact than Alternative 5. About 194 acres of disturbance would occur in the foreground view of sensitive viewpoints assigned the Retention VQO, and 117 acres of disturbance would occur in the foreground view of sensitive viewpoints assigned the Partial Retention VQO (Table 3-140). In addition, about 232 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Retention VQO; 186 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Partial Retention VQO under this alternative (Table 3-140).

The long-term disturbance of NFS land in each VQO class is expected to be less than for Alternative 1 because there would be a smaller number of well pads, compressors, and miles of road constructed on NFS land. There is slightly less disturbance from facilities in the foreground of views from sensitive areas than in Alternative 1, so it is likely that a smaller number of facilities would not meet the Retention VQO. Facilities in the middle ground and background views would meet Partial Retention objectives with implementation of mitigation measures. A smaller number of facilities under this alternative would not be able to meet Partial Retention objectives than under Alternative 1, because fewer facilities are proposed for Alternative 6. The objectives for the Modification VQO would be met for facilities in all distances zones with implementation of mitigation measures.

3.13.3.1.5 Alternative 7

Alternative 7 would result in construction of 250 CBM facilities and 92 miles of road located on federal, state, and private land, resulting in a smaller number of facilities that affect the visual quality of the Project Area than under Alternative 1. Generally, visual impacts would be lower than under Alternative 1 on National Forest System land and the same as Alternative 1 on all other jurisdictions. Table 3-139 summarizes acreages that would be affected by Alternative 7 in each VQO

classification area. Table 3-140 identifies the distribution of visual impacts by sensitive viewpoint, distance zone, and VQO for this alternative. Alternative 7 would disturb the foreground and middle ground views of sensitive viewpoints in the Retention and Partial Retention VQOs less than would Alternative 1. About 206 acres of disturbance would occur in the foreground view of sensitive viewpoints assigned the Retention VQO, and 125 acres of disturbance would occur in the foreground view of sensitive viewpoints assigned the Partial

Retention VQO (Table 3-140). Similarly, approximately 270 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Retention VQO, and 216 acres of disturbance would occur in the middle ground view of sensitive viewpoints in areas assigned the Partial Retention VQO under this alternative (Table 3-140).

The long-term disturbance of NFS land in each VQO class is expected to be less than for Alternative 1, because there would be a smaller number of CBM facilities and miles of road constructed on NFS land. The Retention objectives for facilities on FS lands would not be met where mitigation measures do not effectively maintain the existing character of the landscape so that facilities do not attract the attention of the casual observer. There is less disturbance from facilities in the foreground of views from sensitive areas than in Alternative 1, so it is likely that a smaller number of facilities would not meet the Retention VQO. Partial Retention objectives would not be met for facilities that would be visually evident to the observer and would not be subordinate to the characteristic landscape once mitigation measures have been implemented. Facilities in the middle ground and background views would meet Partial Retention objectives with implementation of mitigation measures. A smaller number of facilities under this alternative would not be able to meet Partial Retention objectives than under Alternative 1, as less disturbance is proposed for Alternative 7. The objectives for the Modification VQO would be met for facilities in all distances zones with implementation of mitigation measures.

3.13.3.2 Sensitivity to Flaring and Compressor Lighting

3.13.3.2.1 Alternative 1 — Proposed Action

A typical CBM well is initially flared for 3 to 5 days. During this time, a large orange flame as tall as 20 feet burns continuously, day and night. During daylight, flaring is prominent only in the foreground distance zone. In the middle ground and background, flaring creates a low visual contrast and in most cases is barely perceptible. However, flaring can have a much greater visual impact during nighttime. Without topographic or vegetative screening, it can be visible for miles at night, which can create a moderate to high visual contrast in the foreground, middle ground, and sometimes background views. This visual impact would be even more pronounced on overcast nights. This analysis estimated that, at most, one to two wells would be flaring at any one time in the Project Area.

Nighttime lighting of compressor stations also would result in increased viewshed sensitivity. Permanent yard lighting has historically been installed for safety and security. This lighting typically consists of low-pressure sodium vapor fix-

tures arranged around the site so that the equipment can be safely operated during darkness.

Of the six existing compressors considered in this analysis, five are in the western portion of the Project Area, where most of the residential development has occurred. Fourteen more compressor sites are proposed in the Project Area. Lighting from these facilities may not draw the attention of casual observers, based on the level of residential development in this portion of the Project Area.

Additional compressors in the eastern portion of the Project Area would have more visual impact associated with night lighting, because of the contrast against the relatively dark night sky in this undeveloped area. The increased contrast would draw the attention of the casual observer during the nighttime. This incremental increase would result in noticeable impacts on the eastern portion of the Project Area, but fewer viewers would be affected by the increase in this part of the area.

3.13.3.2.2 Alternative 2

A larger number of wells would be flaring at any one time in the Project Area compared with Alternative 1. Residents and recreational visitors in the Project Area would experience minor visual impacts during daylight but would observe orange flames or glows in the evening from miles away, where wells are not screened by topography or vegetation. This effect would be particularly pronounced when the sky is overcast.

More compressors would be in the eastern portion of the Project Area, compared with Alternative 1, which would increase visual sensitivity because of the lighting against dark the night sky in a rural, undeveloped area. This contrast would draw the attention of the casual observer during the nighttime.

3.13.3.2.3 Alternative 5 — No Action

Fewer than three wells would flare at any one time in the Project Area. Nighttime impacts in the western side of the Project Area would be the same as were described for Alternative 1. Flaring impacts would be very low in the eastern side of the Project Area, because of the limited amount of development occurring under Alternative 5.

There would be five new compressors under this alternative, the least of all alternatives. Nighttime lighting of compressor stations would be the same as described for Alternative 1 in the western side of the project area, but of no impact on the east side, SJNF portion of the Project Area.

3.13.4 Cumulative Impacts

The cumulative-impacts analysis includes: (1) existing conventional and CBM wells in the SUIT Project Area; (2) conventional and CBM wells projected and approved in the SUIT EIS; and (3) existing and proposed wells and ancillary facilities for each proposed development alternative within the Project Area.

When the existing and proposed oil and gas development are considered together, overall disturbance would increase from 50 to 236 percent from existing development for the alternatives (Table 3-141). Most of this total disturbance would occur in areas classified with the Retention VQO under each alternative. Disturbance in areas classified with Partial Retention VQO and Modification VQO would account for the remainder of disturbance from project facilities and roads.

Table 3-141 Distribution of Existing and Proposed Oil and Gas Development Disturbance in the Project Area by Visual Quality Objective

	Disturbance[1] by Alternative				
Visual Quality Objective	1 (acres)	2 (acres)	5 (acres)	6 (acres)	7 (acres)
Retention	562	738	497	511	597
Partial Retention	327	581	167	419	484
Modification	272	329	71	314	520
Total	1,162	1,649	735	1,244	1,601
Increase over existing	137%	236%	50%	31%	69%

Note:
1. Includes all wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, State, and private lands
2. Does not include one compressor and one injection well totaling 3.5 acres of disturbance located outside of the Project Area boundary. These facilities are not within the area inventoried with VQO classes.

None of the SUIT land was inventoried or analyzed with the FS VMS system. Therefore, the cumulative acres presented in Table 3-142 include the number of acres within each distance zone as viewed from the primary sensitive viewpoints of residences, roads, and recreational areas. The cumulative disturbance acres were presented in this format in the SUIT FEIS. The long-term disturbance from oil and gas development is shown for the SUIT project and from existing development in the second and third columns of the table. The columns under the heading Disturbance by Alternative show the cumulative long-term disturbance from the SUIT acres, existing disturbance in the Project Area, and projected disturbance from each alternative. Alternative 2 would account for the largest amount of disturbance in the foreground distance zones. The SUIT acres account for the majority of cumulative disturbance under any of the alternatives.

Another trend that will increase the magnitude of visual-quality impacts and conflicts is projected growth in La Plata County. It is anticipated that growth will occur along U.S. 160 and near many of the county roads north of U.S. 160. As residential development increases, CBM well operators will be further challenged to meet the criteria for the Partial Retention and Retention VQOs. The number of mitigation measures that can be applied to each well is limited. Furthermore, in some instances, viewers (primarily permanent residents on private land) will be affected by CBM development regardless of the level of mitigation involved.

Table 3-142 Distribution of Cumulative Oil and Gas Development Disturbance by Distance Zone

Sensitive Viewing Area/Distance Zone	SUIT Cumulative (acres)	Existing (acres)	Disturbance[1] by Alternative 1 (acres)	2 (acres)	5 (acres)	6 (acres)	7 (acres)
Residences							
Foreground	4,853	169	5,134	5,176	5,118	5,135	5,135
Middle ground	5,194	124	5,439	5,655	5,390	5,431	5,432
Background	12,976	23	13,438	13,667	13,077	13,194	13,312
Roads							
Foreground	2,243	105	2,455	2,530	2,407	2,474	2,470
Middle ground	3,596	199	4,245	4,629	3,950	4,041	4,140
Background	17,235	12	17,361	17,390	17,278	17,297	17,319
Recreation							
Foreground	225	54	592	816	321	391	464
Middle ground	242	140	638	862	569	590	625
Background	19,222	123	19,447	19,485	19,426	19,425	19,439

Note:

1. Includes all existing and proposed wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, state, and private land in the Project Area, and all cumulative tribal and non-tribal disturbance acreage within the SUIT Study Area.
2. Disturbance acres from residential road and recreation viewing areas overlap; therefore, the areas do not add up to disturbance area totals presented in Chapter 2.

3.13.5 Mitigation and Monitoring

There are two approaches to visual mitigation. First, the site would be situated so that the visual impacts are minimized and the likelihood is reduced that the site would attract attention. Examples of this type of visual mitigation include placing facilities at the base of slopes, instead of on ridges, and designing roads to follow the contours of the land. The design of the facility, the adjacent land uses, and the visual observation points control the level of sensitivity and the number of viewers affected. Careful selection of sites during the siting process can ultimately decrease the level of buffering and landscaping that would be required, so that the site is less likely to attract attention from a casual observer (in other words, sensitivity is decreased). Use of topography and natural vegetation can decrease the costs of visual mitigation for the operator. More important, this approach represents the best mitigation measure possible, because it involves more limited alteration of the natural landscape.

Second, construction and operation at a location would be visually mitigated using specific post-construction and -operation measures that decrease the likelihood that the site would attract attention. This approach can be used in addition to siting mitigation, or when siting mitigation is not feasible. Examples of this type of mitigation include painting facilities in non-reflective natural colors that blend with adjacent vegetation or geologic features, and feathering and rounding the edges of the well pad surface, to reduce obvious contrasts with the natural landform.

The combination of measures used to mitigate any one impact may vary considerably, depending on the nature of the impact and the viewing conditions. The techniques described in this section would be implemented as needed during design of all facilities.

Some of the mitigation measures included in this section may conflict with the measures proposed for other resources. For example, mitigating the straight-line effects created by road and pipeline corridors includes clearing additional vegetation, in an attempt to blend the pipeline with natural features. Clearing may, however, have undesirable impacts on vegetation communities and wildlife habitat in some areas. Conflicts of this nature should receive special attention before any measures are implemented. Roads should be designed to blend into the topography with the lease amount of cut and fill required.

Table 3-143 identifies mitigation measures that would reduce or help minimize the potential visual impacts. These measures are routinely used practice and are an effective means of visual mitigation. Unless otherwise stated, the following measures would be funded by the companies. These measures include:

(1) Wet down and compact roads, where needed, to avoid generating dust and soil loss.

(2) Recontour unused portions of the drill pad reseed per BLM requirements.

(3) Recontour all disturbed areas to blend as nearly as possible with the natural topography. Remove all berms and refill all cuts. Rip all compacted portions of the pad to a depth of 12 inches, unless they are located in solid rock.

(4) Paint all permanent structures (on site for 6 months or longer) in a flat, non-reflective, earth tone color.

(5) Complete interim reclamation as soon as possible so successful re-vegetation can be established to stabilize soils and reduce visual impacts.

(6) Collocate and/or centralize well pads, utilities, pipelines, and production facilities wherever possible to minimize surface impacts and reduce gas field traffic.

Reclamation would be considered successful only when the desired vegetative species are established, erosion is controlled, weeds are considered a minimal threat, and it is likely that ground cover will return to a desirable condition. The operator would continue revegetation efforts until this standard is met, as described in Appendix A.

3.13.6 Conformance to Existing Plans and Policies

3.13.6.1 Conformance with Forest Service Land Use Plans

The LRMP for the SJNF (FS 1983) establishes general long-range direction for managing visual resources and sets forth more specific long-range direction, based on Management Areas.

The VQOs on NFS land for the Project Area are Retention, Partial Retention, and Modification. The objective of Partial Retention is assigned to the majority of NFS land, followed by Modification (Table 3-137, page 3–412). Depending on the alternative chosen, 28 to 200 new gas wells could be constructed within the Partial Retention zone of the Project Area and between 13 and 112 wells would be drilled in the Modification area. Development in these areas could conform to

the designated VQO, as well as the LRMP, if mitigation is implemented during construction and during the on-site monitoring phase. Depending on well site densities and sight distances within a particular area, however, the cumulative effect may exceed the VQO in those areas.

Table 3-143 Potential Effects and Recommended Mitigation

Potential Effect	Recommended Mitigation
Degradation of the visual setting because of the contrast between exposed soils and surrounding vegetated areas.	Use existing vegetation and topographic features to screen wells, facilities, and roads. Require vigorous, self-sustaining vegetation (that does not burn off after grazing) as a reclamation measure.
Degradation of the visual setting because of high visibility of well development facilities.	All development components will meet agency guidelines for color as specified in the COA. Colors will be of natural earth tones that match surrounding summer vegetation or rocks. The Forest Service will approve colors.
Strong contrast between new construction and surrounding vegetated areas.	Landscaping will blend the site developments into the surrounding landscape. Native tree, shrub, and grass species will be employed in landscaping. Minimize the height of the pumping unit where possible, use vegetative and topographic screening when siting well locations, design well pad and facilities with scalloped edges in wooded areas, avoid high wall cuts, and shield lights from the drilling rig.
Clearing of vegetation for pipeline installation, creating prominent linear features in the landscape.	Removal of vegetation may be necessary for pipeline installation, unless the pipeline is to follow the alignment of the access road. Where possible, the area will be cleared in a non-linear fashion to blend the clearing with the surrounding vegetation. Native tree, shrub, and grass species will be employed in revegetation. Employ vegetative edge feathering in sloped areas that are fully visible from sensitive areas, such as roads, use areas, and residences.
Construction of new well pads access roads, creating prominent linear features in the landscape.	Avoid straight line-of-sight road construction and design roads through wooded areas to follow a curvilinear path using natural topography. All road designs would consider the requirements of the anticipated vehicles, including travel way, width, grade, curve radius, sight distance, and design speed. Avoid road construction across ridge tops where it may cause a contrast in the landscape or add skyline alterations that would call attention to their addition. Avoid road construction across ridge tops.
Deterioration of the night dark sky scenic values due to security lighting	Install light sensitive, motion activated lighting systems that are illuminated only when needed for security maintenance. Light fixtures should be hooded to prevent horizontal light bleeding.

An estimated 60 to 75 wells are proposed in the Retention zone that are in the foreground viewing-distance zone (up to 0.5 mile from the observer), depending on the alternative considered. The existing gas wells in the foreground viewing-distance zone generally do not meet the Retention VQO, because of their visibility and prominence. It is unlikely, therefore, that the VQO will be met in the

foreground for the proposal. Although mitigation measures would lessen the visual impact, the nature of the gas well facilities makes it difficult, if not impossible, to blend into the characteristic landscape in a way that is not obvious to anyone viewing them within this close range.

The proposed new gas wells within the middle ground and background distance zones may meet the Retention VQO if the mitigation measures are adopted during the design and siting phases and are enforced during the monitoring phase.

Considering the total area, the potential for major visual disruption would not be from the gas well facilities, but from the network of access roads associated with the proposal. The linear alterations of the landscape that result from road construction would be moderately to highly visible from all distance zones.

3.13.6.2 Conformance with BLM Land-Use Plans

As previously discussed, the FS inventory was expanded to include BLM land as well as private and state land, because BLM land in the Project Area had not been inventoried with the VRM and this approach was deemed advisable to maintain consistency in the analysis of visual resource management. For this analysis, conformance with the BLM RMP can be assessed assuming that the BLM Class II Objective approximates the FS Retention VQO, BLM Class III Objective approximates the FS Partial Retention VQO, and BLM Class IV Objective approximates the FS Modification VQO. Based on these assumptions, most of the BLM land within this Project Area is assigned Class II and III objectives, and small portions are assigned Class IV.

As discussed in the previous section, proposed gas wells developed in the Retention VQO (Class II Objective) would probably not meet that objective in the foreground distance zone, particularly if they are completed in the visual vicinity of existing gas wells. The cumulative effect of the existing and proposed development would most likely not conform to the requirements of this objective. New gas well development in the middleground and background distance zones, as well as those in the Class III and Class IV objective areas, could meet the visual objectives if it incorporates mitigation measures during siting and construction. Still, these visual objectives may not be met, because of the cumulative effects of the existing and proposed development, combined. In addition, the linear effect of the road system would alter the character of the landscape, as the roads are likely to attract the attention of the viewer with the visual contrast in color, form, line, and texture, as well as the activities associated with the road corridors.

3.13.7 Unavoidable Adverse Effects

Unavoidable adverse effects would occur under each of the alternatives. The types of impacts would be the same for each alternative. The primary difference among alternatives is the number of CBM facilities located within the foreground and middle ground of views from residential areas, roads, and recreation areas. The extent of unavoidable adverse impacts would be greatest under Alternative 2, followed by Alternatives 1 and 5. The visual quality of the Project Area landscape would be degraded for the viewing areas where wells are sited within foreground and middle ground zones. The objectives for some wells on NFS lands

managed in the Retention, Partial Retention, and Modification VQO areas would not be met under any of the alternatives if mitigation measures do not enable facilities to blend with the landscape. Adverse effects to the visual quality of the HD Mountains landscape would occur under all alternatives.

3.13.8 Irreversible and Irretrievable Effects

No irreversible effects would occur to visual resources. Post-project reclamation would return affected landscapes to a condition approximating pre-project conditions.

Irretrievable effects that would occur for the life of the project would be the addition of an industrial element to rural or natural landscapes.

3.14 Noise

3.14.1 Issues

This section discusses noise impacts that could result from further CBM development in the Project Area. The impact of facility construction and operation noise on wildlife is addressed in the Section 3.9 of this chapter. The effects of CBM facilities and noise on property values is addressed in Section 3.15 below. The following are noise issues raised during the scoping process.

Issue 11: The effect of additional CBM development on area noise.

- What are the day and nighttime noise levels associated with construction, drilling, and operation of CBM facilities?
- Does noise from CBM development and operation affect property values?
- Does noise from CBM development and operation affect wildlife?
- Are there intrusive vibrations, especially from cavitation and fracturing operations, that affect sensitive receptors (SR's) such as outdoor living space around residences?

3.14.2 Affected Environment

Noise is unwanted sound. Discussions of environmental noise do not focus on pure tones because the frequency and pressure characteristics of commonly heard sounds are complex. Accordingly, sound-measurement equipment has been designed to account for the sensitivity of human hearing to different frequencies. Correction factors that adjust actual sound pressure to correspond with human hearing have been established experimentally. A-weighted correction factors are employed for measuring human-perceived noise in ordinary environments. The filter de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. Therefore, the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise.

The dBA measurement is bases on a logarithmic scale of sound pressure. To the average human ear, the apparent increase in "loudness" doubles for every 10 dBA increase in noise (Bell 1982). Taking a baseline 60 dBA as the noise level experienced in normal conversation with two people standing 5 feet apart, noise of 50 dBA would be half as loud, and noise of 70 dBA would be twice as loud.

The EPA has established a level of 55 dBA as a guideline threshold for acceptable environmental noise (EPA 1974). This is used as a basis for evaluating effects from noise when no other local, county, or state standards have been established. The EPA guideline level was defined by scientific consensus without concern for economic and technological feasibility, and contains a margin of safety to ensure its protective value of the public health and welfare.

This guideline level is directed at areas where people would be exposed to an average noise level over a specific period. In this context, public health and wel-

fare include personal comfort and well-being and the absence of mental anguish, disturbances, and annoyance, as well as the absence of clinical symptoms such as hearing loss or demonstrable physiological injury. Therefore, a 55-dBA guideline threshold is not a regulatory goal. Rather, 55 dBA should be recognized as a level below which there is no reason to suspect that the public health and welfare of the general population would be at risk from any of the effects of noise identified.

COGCC regulates noise from CBM facilities under its Aesthetic and Noise Control Regulation 802, Noise Abatement (COGCC 2004a). This regulation states that noise from operation of CBM facilities shall not exceed 55 dBA at residential areas from 7:00 a.m. to 7:00 p.m. and shall not exceed 50 dBA from 7:00 p.m. to the following 7:00 a.m. However, higher noise levels are permitted for any operation that involves construction, drilling, completion, or workover of CBM facilities. Noise from construction and maintenance must not exceed 80 dBA from 7:00 a.m. to 7:00 p.m. and 75 dBA from 7:00 p.m. to the following 7:00 a.m. Noise levels permitted for construction and maintenance may be increased by an additional 10 dBA for a period not to exceed 15 minutes in any hour from 7:00 a.m. to 7:00 p.m.

The COGCC noise regulation specifically applies to residential areas. However, COGCC Safety Regulation 600 (COGCC 2004b) established minimum setback distances from surface property lines or structures for wells and production facilities. Although this COGCC regulation is related to safety issues, it also serves as a *de facto* noise regulation because it provides for a buffer distance between surface property lines or structures and CBM facilities. Under the regulation, wells and associated production facilities shall be situated not less than 350 feet from any building unit, educational facility, assembly building, hospital, nursing home, board and care facility, or jail. These areas are collectively referred to as Noise Sensitive Areas (NSAs) in this noise-impact analysis.

A review of the applicable planning documents (BLM 1984b; FS 1983, 1992) indicates there are no applicable noise standards within the Project Area. Therefore, the COGCC standards are considered as criteria to evaluate impacts from noise for this EIS.

3.14.2.1 Typical Noise Levels

The following discussion presents a reference of familiarity with common noise levels. These levels are intended to represent the average noise over a specified period (for example, a 24-hour interval or a yearly average) in various land-use areas. Depending on the location and the quantity and type of noise sources, these levels can vary widely, but are generally within 3 to 5 dBA (EPA 1974) above or below the "average" value. Table 3-144 shows examples of noise levels generated by commonly experienced sources in various land-use areas.

3.14.2.2 Existing CBM-Related Noise

Noise levels are elevated around CBM facilities. Noise is produced by vehicle and equipment usage, construction and drilling operations, small gas-fired engines, and operating pump jacks operating to extract the natural gas. This section

describes the estimated noise levels near these facilities. The levels are intended to represent the noise expected at NSAs located away from these activities.

Table 3-144 Typical Noise Levels

Noise Source	Average Noise (dBA)	Loudness[1]	Range of (dBA)
Ambulance siren (100 feet)	100	16 times greater	95-105
Motorcycle (25 feet)	90	8 times greater	85-95
Typical construction site	85	6 times greater	80-90
Single truck (25 feet)	80	4 times greater	75-85
Urban shopping center	70	2 times greater	65-75
Single car (25 feet)	65	1.5 times greater	60-70
Within 100 feet of a highway	60	1	55-65
Normal conversation (5 feet apart)	60	1	57-63
Residential area during day	50	50%	47-53
Recreational area	45	50%	40-50
Residential area at night	40	25%	37-43
Rural area during day	40	25%	37-43
Rural area at night	35	< 14%	32-37
Quiet whisper	30	< 12%	27-33
Threshold of hearing	20	< 6%	17-23

Note:
1. Loudness based on 60 dBA, the noise level experienced in conversation between two people 5 feet apart
Sources: EPA 1974, Harris 1991

Noise is estimated using a level measured near the activity and then predicted at distances farther away, based on the Inverse Square Law of Noise Propagation, which states that noise will decrease (attenuate) by 6 dBA every time the distance from the source is doubled (Harris 1991). This methodology of estimating noise attenuation is represented by:

$$L_2 = L_1 - 20 \log (R_2/R_1)$$

where:

L_2 = noise level at a selected distance R_2 from the source

L_1 = noise level measured at a distance R_1 from the source.

3.14.2.3 CBM Construction

Noise impacts during the construction phase result from the operation of vehicles and construction equipment. Table 3-145 shows the approximate levels of noise experienced when standing 50 feet from various types of construction equipment. The table also shows how the noise decreases with distance from the equipment.

Not all construction equipment operates continuously, so the average noise level during well pad construction is estimated to be 85 dBA. Using the propagation formulation, average noise levels decrease below 55 dBA about 1,700 feet from construction sites (Table 3-146). Any NSAs within 1,500 feet of construction, therefore, would experience temporary noise levels above 55 dBA during day-

light hours. Nighttime noise levels are not usually affected, because construction typically occurs between 7:00 a.m. and 7:00 p.m.

Table 3-145 Levels of Noise Generated by Various Types of Construction Equipment

	Noise Level at:				
Equipment Type	50 Feet (dBA)	500 feet (dBA)	1,000 feet (dBA)	1,500 feet (dBA)	2,000 feet (dBA)
Crane	88	68	62	58	56
Backhoe	85	65	59	55	53
Pan Loader	87	67	61	57	55
Bulldozer	89	69	63	59	57
Fuel and Lubrication Truck	88	68	62	58	56
Water Truck	88	68	62	58	56
Motor Grader	85	65	59	55	53
Vibrator/Roller	80	60	54	50	48
Mechanic Truck	88	68	62	58	56
Flat Bed Truck	88	68	62	58	56
Dump Truck	88	68	62	58	56
Flat Bed Trailer	88	68	62	58	56
Tractor	80	60	54	50	48
Concrete Truck	86	66	60	56	54
Concrete Pump	82	62	56	52	50
Front End Loader	83	63	57	53	51
Road Scraper	87	67	61	57	55
Air Compressor	82	62	56	52	50
Average Construction Site	85	65	59	55	53

Source: Crocker and Kessler 1982

Noise during the drilling phase would also be elevated above pre-existing levels. Typically, the noise from a drilling rig is 74 dBA at 200 feet (USGS 1981). Noise from drilling rigs would decrease from 60 dBA at 1,000 feet to 50 dBA at 3,000 feet (Table 3-146). These levels are experienced for 24 hours per day for the 8 days generally required to drill a CBM well. The noise impacts from drilling a water disposal well would be similar to a CBM wells, but would last longer because of its greater depth.

3.14.2.4 Operational Noise Levels

Noise levels would decrease substantially after the well pads, roads, and pipelines have been constructed and the wells have been drilled. Sources of operational noise would involve periodic vehicle trips to the well sites and the pump jacks. Typical noise from a pumping unit operating up to 24 hours per day is 61 dBA at 100 feet (USGS 1981). Noise from pump jacks would decrease to 55 dBA at 200 feet and 41 dBA at 1,000 feet (Table 3-146).

Table 3-146 Noise Impacts from CBM Facilities

Distance from CBM Facility (feet)	Noise from Compressor Station with one engine (dBA)	Noise from Compressor Station with two engines (dBA)	Noise from Pump Jack (dBA)	Noise from drill Rig (dBA)	Noise from Construction (dBA)
50	69.0	72.0	67.0	86.0	85.0
100	63.0	66.0	61.0	80.0	79.0
150	59.5	62.5	57.5	76.5	75.5
200	57.0	60.0	55.0	74.0	73.0
250	55.0	58.0	53.0	72.1	71.0
300	53.4	56.4	51.5	70.5	69.4
350	52.1	55.1	50.1	69.1	68.1
400	50.9	53.9	49.0	68.0	66.9
450	49.9	52.9	47.9	67.0	65.9
500	49.0	52.0	47.0	66.0	65.0
550	48.2	51.2	46.2	65.2	64.2
600	47.4	50.4	45.4	64.5	63.4
650	46.7	49.7	44.7	63.8	62.7
700	46.1	49.1	44.1	63.1	62.1
750	45.5	48.5	43.5	62.5	61.5
800	44.9	47.9	42.9	62.0	60.9
850	44.4	47.4	42.4	61.4	60.4
900	43.9	46.9	41.9	60.9	59.9
950	43.4	46.4	41.4	60.5	59.4
1,000	43.0	46.0	41.0	60.0	59.0
1,100	42.2	45.2	40.6	59.6	58.6
1,200	41.4	44.4	40.2	59.2	58.2
1,300	40.7	43.7	*39.8*	58.8	57.8
1,400	40.1	43.1	39.4	58.4	57.4
1,500	39.5	42.5	38.7	57.7	56.7
1,600	38.9	41.9	38.1	57.1	56.1
1,700	38.4	41.4	37.5	56.5	55.5
1,800	37.9	40.9	36.9	55.9	54.9
1,900	37.4	40.4	36.4	55.4	54.4
2,000	37.0	40.0	35.9	54.9	53.9
2,500	35.0	38.0	33.0	52.1	51.0
3,000	33.4	36.4	31.5	50.5	49.4
3,500	32.1	35.1	30.1	49.1	48.1

The noise from a pump jack is rhythmic, however, rather than the steady sound of smoothly running equipment. Therefore, although the noise level would be well below the 55-dBA significance threshold, it may be as noticeable as higher noise levels for some people.

Noise from one compressor engine enclosed in a building is about 89 dBA at 5 feet (USGS 1981). Noise from a compressor engine enclosed in a building typically is 69 dBA measured 50 feet from the edge of the building. If two compressor engines are operating, the noise is typically 3 dBA higher, or 72 dBA at 50 feet. Three compressor engines produce a noise of 74 dBA at 50 feet. Based on the noise attenuation equation, noise from compressor stations is below the COGCC night-noise standard (50 dBA) at 450 feet for one compressor engine

and 650 feet for two engines (Table 3-146). Noise from compressor stations with three engines would be below the COGCC night-noise standard at 770 feet. A noise level of 50 dBA would be audible inside residences with open windows during the night, however, because the typical background nighttime noise level in rural residential areas is 35 to 40 dBA.

3.14.2.5 CBM Noise Complaints

Since June 1997, COGCC has investigated 44 complaints about noise generated by CBM operations in La Plata County, 12 within the Project Area and 32 outside the Project Area.

In the Project Area, two complaints involved compressor facilities, three involved well drilling, three resulted from truck noise, and four were about noise from operation of wells. Two of the 12 complaints resulted in a Notice of Violation, because the noise exceeded COGCC limits. The Notices of Violation involved operation of a compressor station in T35N R8W Section 36 and a pump jack in T35N R8W Section 24. Both of these complaints were filed and resolved in 1997. The operator of the compressor station installed walls around the compressor building, and the noise level decreased below the COGCC limit. An operator also installed a wall around the pump jack, and the noise decreased to acceptable limits. Investigations of the other complaints demonstrated that noise levels were below the COGCC limits.

Outside the Project Area, 21 of the 32 complaints involved compressor facilities. Notices of Violation were issued for six of these facilities, and the operators installed walls to decrease noise below COGCC limits. Investigation of the other complaints, which involved the operation and maintenance of wells, found that these operations produced noise at levels below the COGCC limits.

3.14.3 Environmental Consequences

3.14.3.1 CBM Daytime and Nighttime Noise

The overall impact of noise is a function of the number of locations that are affected by noise from CBM related sources. This section describes the noise of individual CBM activities, as well as the total effect in a square mile (section) of development. Development under Alternative 2 (514 wells) would produce elevated noise levels in the Project Area at the largest number of locations; development under Alternative 5 (117 wells) would produce similar levels of noise but at the fewest locations.

3.14.3.1.1 Alternative 1 — Proposed Action

Elevated noise levels would result from vehicles and operation of construction equipment during each phase of construction. Construction noise would be temporary, however, at each location. Well pad construction would last less than 36 days. Road construction would require about 7 days for each mile. The maximum noise level during CBM facility construction is assumed to be 85 dBA at 50 feet from the site. Using the noise attenuation equation described above, the levels would fall below the COGCC construction daytime limit of 80 dBA at 100 feet from construction areas. Because construction normally would occur be-

tween 7:00 a.m. and 7:00 p.m., nighttime noise levels would not be affected by construction. Compressor-station construction would require 1 to 2 months and would create the same type of impacts as site construction, but over a longer duration.

Noise generated during the construction and operational phases of the project would be similar to those described above for existing CBM-related noise. Noise during the drilling phase would exceed pre-existing levels (74 dBA at 200 feet from the rig). Additionally, it would ensue 24 hours a day for the 8 days that are generally needed to drill a CBM well. During the operational phase, sources of noise would then be limited to periodic vehicle trips to the well sites and the pump jacks. Noise emanating from pump jacks would range from 67 dBA at 50 feet from the well to 50 dBA at 375 feet (Table 3-146).

A Caterpillar model 3516 is typical of the engines that would be installed at compressor stations. Two sources make up the total noise from this engine. According to Caterpillar, the exhaust produces a noise of 109 dBA at 4.9 feet. The mechanical noise from the engine produces 99 dBA at 3.2 feet. To calculate the total noise from this engine, the two are combined, resulting in a total source noise of 109.4 dBA at 4.9 feet. The enclosed building where the compressor engine would operate would reduce noise by about 20 dBA (Cohn 1981). Therefore, the effective noise level would be 89.4 dBA at 5 feet from the edge of the building enclosure.

The noise emanating from the compressor would decrease to 55 dBA (the COGCC daytime limit) at 250 feet from the edge of the compressor building, and to 50 dBA (the COGCC nighttime limit) at 450 feet from the building. Table 3-146 shows the average noise levels that can be expected at increasing distances from CBM facilities. For example, the noise emanating from a two-engine compressor station would result in a level of 55 dBA at 350 feet from the edge of the compressor building and 50 dBA at 650 feet from the building.

This analysis suggests that the noise from any permanent CBM activity would be below 40 dBA, a typical average background noise at night, 2,000 feet from the facilities. If a two-engine compressor station were located at least 650 feet from NSAs, the COGCC regulatory noise standards would be met during both the day and night. The COGCC nighttime standard would also be met if the pump jacks would be 375 feet from any NSAs. Therefore, the COGCC safety regulations would preclude placement of any two-engine compression facility within 375 feet of an NSA.

The impacts above describe the noise produced by a single compressor station or pump jack. The effect of multiple facilities must be considered, however, to calculate the total impact on noise from CBM activities.

CBM production would be widespread throughout the Project Area. A variety of locations could have a two-engine compressor station and four wells at 160-acre spacing. Therefore, a similar scenario is developed to demonstrate the total noise effects of CBM facilities. The scenario, shown on Figure 3–71, considers a square mile with a compressor station in the center and four pump jacks centered in each quadrant of the square mile. In this example, the compressor building and

the pump jacks are separated by 1,900 feet. For a graphical comparison of noise from a single source, compared with noise produced by multiple sources, the noise produced only by the two-engine compressor station is also shown on Figure 3–71.

A grid was established to calculate predicted noise at each grid point spaced every 200 feet within this hypothetical square mile. The noise from each source was then calculated at every grid point, using the noise attenuation equation described previously. Similar to the effect of collocated sources, the total noise at a location produced by two or more sources is not a simple addition of the noise from multiple sources, but rather is a logarithmic summation.

The results of the noise modeling are shown in Figure 3–71. When the facilities are equally spaced, the 55-dBA and 50-dBA noise contours from the compressor station and the pumping facilities expand slightly in response to the contribution from the pump jacks. For example, the predicted distance where the noise level is 50 dBA from a two-engine compressor station increases by 40 feet when the total effect of the pump jacks is considered. When the total noise from CBM facilities within a square mile is considered, the noise levels would be below the COGCC nighttime noise standard of 50 dBA in about 90 percent of the area. The noise would, however, be above 35 dBA, the average nighttime noise in a rural area, in nearly 80 percent of the area. Therefore, nighttime noise from CBM development would be audible within the same square mile of a two-engine CBM compression station, and four pump jack engines, even in the absence of other sources, such as traffic near major roads or moderate to high wind.

Although noise levels near all CBM facilities would be similar, CBM development in the eastern portion of the Project Area would occur on NFS land more distant from populated areas and would not affect established NSAs. Noise from CBM development on intermingled private, State, and BLM mineral estate could affect NSAs in the western portion of the Project Area, however. Alternative 1 proposes 69 well locations or windows within or immediately adjacent to the existing and proposed subdivisions shown on Figure 3–41.

Noise could be an issue based on the proximity of NSAs within these subdivisions. Adherence to COGCC regulatory noise standards would preclude placement of wells within 350 feet of any NSAs identified within these areas. However, noise from the pump jacks could slightly exceed the 50-dBA nighttime COGCC limit within 375 feet of wells. Therefore, the minimum setback distance should be evaluated and possibly increased for any wells that would be located near NSAs.

CBM development on National Forest would minimally affect residential properties because of the relatively great distances of National Forest well sites for private land. The area of concern would be Sauls Creek which is an intermix of National Forest and private land that currently has scattered home sites. Most proposed wells on National Forest within Sauls Creek are at least 2,000 feet from the Forest Boundary. So terrain and distance from private land present effective mitigation potential. There are, however, some well sites within closer proximity of private land that could present conflicts. Where any new wells may be within proximity of a residential tract, they would be sited to eliminate residential im-

pacts where potential noise conflicts are an issue. Other mitigation measures, as listed in Section 3.14.5, would also be utilized to reduce noise as applicable.

3.14.3.1.2 Alternative 2

Similar to Alternative 1, CBM development in the eastern portion of the Project Area would occur on NFS land distant from populated areas and would not affect established NSAs. Noise from CBM development on intermingled private, State, and BLM mineral estate would affect NSAs in the western portion of the Project Area, with the levels of impact similar to Alternative 1.

Under Alternative 2, 95 well locations or windows are proposed in or immediately adjacent to the existing and proposed subdivisions shown on Figure 3–41. Noise could be an issue, based on the proximity of NSAs in these subdivisions. Adherence to COGCC regulatory noise standards would preclude placement of wells within 350 feet of any NSAs identified within these areas. However, noise from the pump jacks could slightly exceed the 50-dBA nighttime COGCC limit within 375 feet of wells. Therefore, the minimum setback distance should be evaluated and possibly increased for any wells that would be located near NSAs.

There would be 22 wells constructed on BLM land as opposed to 12 wells in Alternative 1. The additional wells in this intermingled area of BLM, private, and State wells would contribute to noise impacts in the western project area. The BLM would utilize well siting to minimize the potential for noise impacts to residential areas. Other noise reduction measures, as described in Section 3.14.5, would also be utilized on a site-specific basis as needed.

The noise impacts of CBM development on National Forest would be as described for Alternative 1.

3.14.3.1.3 Alternative 5—No Action

A total of 14 wells would be developed on split estate National Forest lands in the eastern Project Area and no development would occur on BLM mineral estate in the western part of the Project Area. The wells constructed on National Forest split estate lands would not be in very close proximity to residences and would probably have no effect on the few residential properties that exist in the far eastern Project Area. Noise from private and state mineral estate development would affect NSAs in the western portion of the Project Area, with the level of impacts similar to Alternative 1.

Under Alternative 5, 52 well locations or windows are proposed in or immediately adjacent to the existing and proposed subdivisions shown on Figure 3–41. Adherence to COGCC regulatory noise standards would preclude placement of wells within 350 feet of any NSAs identified within these areas. However, noise from pump jacks could slightly exceed the 50 dBA nighttime COGCC limit within 375 feet of wells. Therefore the minimum setback distance should be evaluated and possibly increased for any wells that would be located near NSAs.

3.14.3.1.4 Alternative 6

Under Alternative 6, 72 well locations or windows are proposed in or immediately adjacent to the existing and proposed subdivisions as shown on Figure 3–

41. The impacts from noise associated with Alternative 6 would be similar to Alternative 1.

Wells constructed on BLM lands would be the same as Alternative 1 and these wells are located in the mixed jurisdictional potion of the western Project Area. The 11 BLM wells constructed under Alternative 6 would contribute to noise that may affect residences. Therefore, where these potential for noise impacts exist, the use of terrain features to block noise, and the minimum setback distance would be possibly increased for any wells that would be located near NSAs.

CBM development would not occur in the HD Mountains Roadless Area and in the 1½-mile Fruitland Formation outcrop zone under Alternative 6, and thus there would be 103 fewer wells constructed on National Forest land as compared to Alternative 1. Since these 103 well sites are on National Forest and geographically isolated from residential development, their elimination from development would have no mitigating effect on noise. Thus, the noise impacts associated with National Forest CBM development would be similar to Alternative 1.

The one area of potential noise conflict would be CBM development of National Forest lands in the Sauls Creek area. The area is an intermix of National Forest and private lands that has light residential development. New wells on National Forest, if within proximity of a residential tract, would be sited to eliminate residential impacts where potential noise conflicts are an issue, and other mitigation listed in Section 3.14.5 would be utilized as needed.

3.14.3.1.5 Alternative 7

Under Alternative 7, 67 well locations or windows are proposed in or immediately adjacent to the existing and proposed subdivisions as shown on Figure 3–41. The impacts from noise associated with Alternative 7 would be similar to Alternative 1.

Wells constructed on BLM lands would be the same as Alternative 1 and these wells are located in the mixed jurisdictional potion of the western Project Area. The 11 BLM wells constructed under Alternative 6 would contribute to noise that may affect residences. Therefore, where these potential for noise impacts exist, the use of terrain features to block noise, and the minimum setback distance would be possibly increased for any wells that would be located near NSAs.

CBM development on National Forest would not occur in some locations within the HD Mountains Roadless Area, and thus there would be 47 fewer wells constructed on National Forest land as compared to Alternative 1. Since these 47 well sites are on National Forest and geographically isolated from residential development, their elimination from development would have no mitigating effect on noise. Thus, the noise impacts associated with National Forest CBM development would be similar to Alternative 1.

As with the other action alternatives, the one area of potential noise conflict would be CBM development of approximately 13 wells on National Forest lands in the Sauls Creek area. The area is an intermix of National Forest and private lands that has light residential development. Most of the National Forest well windows in Sauls Creek are located at least 2000 feet from private land bounda-

ries, and thus distance and terrain both act to reduce the potential for noise impacts to residences. However, where any new wells may be within proximity of a residential tract, they would be sited to eliminate residential impacts where potential noise conflicts are an issue. Other mitigation measures listed in Section 3.14.5 would also be utilized to reduce noise where needed.

3.14.3.2 Effect of Intrusive Vibrations from Cavitation and Fracturing Operations

We expect, based on industry response, that 100 percent of the CBM wells would be fracture stimulated in the eastern Project Area. On the western side, the companies would use fracturing at 75 percent of the wells and cavitation on up to 25 percent, to stimulate well production.

Noise and vibration are not expected to be significant under any of the alternatives because of the depth of the completion methods. Short bursts of noise may be audible over the 2-week period when cavitation would be employed. However, cavitation would be employed only during daylight hours from 7 a.m. to 7 p.m.

3.14.4 Cumulative Effects

The prominent sources of noise in and next to the Project Area are widespread oil and gas development; traffic, especially on Highway 160, residential areas, and occasional airplane traffic at the La Plata County Airport south of the Project Area. Additional noise sources in the Project Area are expected to occur with commercial and industrial development along Highway 160 east of the Florida River and near Bayfield.

As described above, the noise effect of individual CBM facilities is localized. Furthermore, because wells and compressor stations would be separated by sufficient distance, the cumulative effect of numerous facilities in a specific area would be limited. Compressor stations would have the highest potential to increase general localized noise if located near other existing and future sources of noise. The pump jacks at each well pad would not produce sufficient noise to interact significantly with other sources to raise the overall noise within a localized area.

The CBM compressor stations may contribute to a slight cumulative increase in noise in the Project Area. Under all alternatives, two compressor stations would be constructed near the proposed industrial and commercial development along Highway 160 east of the Florida River. The compressor stations and the industrial and commercial development would likely result in slightly higher overall noise in this area. Under all alternatives, two or three compressor stations would be constructed northeast of Bayfield near existing and proposed residential developments. The combination of increased residential activity and additional compressor stations would increase noise levels slightly here and increase the potential for noise conflict with residences.

Because no compressor stations are proposed for the Bayfield area, overall noise is not expected to increase significantly on a cumulative basis. All other com-

pressor stations would be constructed at sufficient distances from existing and proposed noise sources so as not add significantly to the overall noise levels.

3.14.5 Mitigation and Monitoring

The following mitigation measures are recommended to reduce noise levels from CBM sources. Unless otherwise stated, the following measures would be funded by the companies.

- Increase the distance between a CBM facility and an NSA. As shown in the analysis, noise decreases by 6 dBA with every doubling of distance from a source. For instance, if the noise were 55 dBA at 100 feet from a CBM source, the noise would decrease to 49 dBA at 200 feet from the source and to 43 dBA at 400 feet from the source.
- Enclose noise sources, including compressor stations. As shown in the impact analysis, closed buildings generally result in about a 20-dBA attenuation of noise from compressor engines.
- Install noise mufflers and/or direct exhaust vents away from nearby NSAs. This procedure would reduce the noise directed toward a potentially affected NSA.
- Construct obstacles to noise in the direct path from the source of noise to a receiver. Such obstacles can be tightly spaced wood fences (no gaps in the wood panels), concrete fences, earth berms, or structures.

Barriers placed on CBM facility property boundaries aligned between the facility and the noise-sensitive receptors could achieve at least a 5-dBA reduction in noise level when they are tall enough to break the line of sight between the noise source and the receptor. An additional 1.5-dBA reduction can generally be achieved with each 3.5 feet of height after it breaks the line of sight.

All of the above noise mitigation measures have been applied in individual situations to CBM facilities and have proven effective in reducing noise to acceptable levels.

3.14.6 Conformance to Existing Plans and Policies

Construction and operation of project facilities under all alternatives are expected to conform to existing federal plans and policies and COGCC's regulations. Where facilities do not meet standards identified in existing plans and policies outright, use of the mitigation measures identified above is expected to enable the companies to construct and operate their facilities in conformance.

3.14.7 Unavoidable Adverse Effects

Implementation of any of the alternatives would result in an increase in local noise around project facilities in the Project Area. This increase in noise would be unavoidable.

3.14.8 Irreversible and Irretrievable Effects

Noise effects from CBM facilities would cease after the life of the project. Therefore, there would be no irreversible or irretrievable effects of noise.

3.15 Social and Economic Values

3.15.1 Issues

Issue 4 The effects of additional CBM development on the socioeconomic environment.

- Will the visual consequences of CBM development affect tourism and tourism revenues and the sales tax revenue, employment, and income tax proceeds derived from tourism?
- Will continued CBM development contribute to a boom-or-bust economy? If so, how will that economic cycle affect quality of life in the affected counties?
- How will continued CBM development affect county revenues from gas royalties and taxes? In addition, how does development affect sales and taxes?
- How will continued CBM development affect demographics, employment, and infrastructure? What are the overall costs and benefits of the proposed project?
- How will gas wells on or near residential properties affect the value of those properties?
- Does CBM development affect property values? If so, is it reflected in reduced valuation on the county tax rolls? Reduced property valuations would result in lost property taxes to the county.
- How will continued CBM development affect the quiet nature and way of life in the project area? Will it result in out-migration of and reduced population numbers? How will it affect traffic and noise?

3.15.2 Affected Environment

The Project Area includes portions of La Plata and Archuleta Counties. La Plata County contains most of the population and private land that require county services. The eastern part of the Project Area in Archuleta County is primarily federal land and includes part of the HD Mountains. The data used for this section are countywide, however, because the area of influence considered for social and economic values is larger than the Project Area.

The SUIT Reservation in La Plata and Archuleta Counties is south of and next to the Project Area. The SUIT Reservation holds CBM resources and is the location of current and anticipated CBM development. A separate analysis of the impacts of current and anticipated CBM development of resources in the SUIT Reservation was completed in 2002 (BLM et al. 2002).

Existing oil and gas facilities in the NSJB reflect past development of both conventional and CBM wells; however, there are relatively few conventional wells in the Project Area. Since 1988, most new development of oil and gas in the Project Area has been CBM.

3.15.2.1 Population, Employment, Earnings, and Income

The population, employment, earnings, and income characteristics for the Project Area are summarized in this section.

3.15.2.1.1 Population

The estimated July 2004 population for La Plata County is 47,173 (Colorado Department of Local Affairs [CDOLA] 2005a). The estimated 2004 population of the City of Durango is more than 15,600 (CDOLA 2005a). Durango is the center for population and trade nearest to the Project Area. The city is about 2 miles west and northwest of the western edge of the Project Area. The Town of Bayfield, with a 2004 population of about 1,700, is near the center of the Project Area. Bayfield has historically been a farm and ranch region and is now becoming a bedroom community for Durango.

As shown in Table 3-147, Table 3-148, and Table 3-149, the 1990s were a period of high population growth for both Archuleta and La Plata Counties, as well as for the entire State of Colorado. Between 1990 and 2004, La Plata County grew by 46 percent and Archuleta County more than doubled in population, while Colorado's total population increased by 41 percent. Archuleta County experienced extremely high population growth between 1993 and 1998, with 5 consecutive years of annual growth above 5 percent. Archuleta County is currently listed as one of the 100 fastest growing counties in the U.S.

The estimated July 2004 population for Archuleta County is 11,464 for Archuleta County (CDOLA 2005a). Archuleta County is listed as one of the 100 fastest growing counties in the U.S. Pagosa Springs, Archuleta County's only municipality, grew by 32 percent during the 1990s. At the same time, the unincorporated areas of the county more than doubled in population, from 4,138 residents in April 1990 to 13,084 residents in July 2004. As a result of this differential pattern of growth, a larger share of Archuleta County residents lived in unincorporated areas in 2004 than in 1990.

Population growth is the result of both natural increases (number of births compared with number of deaths) and net migration. The population tables also show net migration. Throughout the 1990s, the contribution of net migration to population growth was larger than natural increases. From 1992 to 1999, net migration contributed almost 83 percent of the growth in La Plata County and 92 percent of the total population growth for Archuleta County. This percentage is higher than the relative population increase of 70 percent attributable to net migration for the state as a whole. Development of CBM was also rapidly increasing in the Project Area during the population growth in the 1990s, as discussed in Section 3.4, Geology.

Table 3-147 Population Estimates for La Plata County, Colorado, 1990–2004

Parameter/Location	Date											July-04
	Apr-90	Jul-91	Jul-92	Jul-93	Jul-94	Jul-95	Jul-96	Jul-97	Jul-98	Jul-99	Apr-00	
County and Municipal Populations												
La Plata County	32,284	33,411	34,429	35,598	36,906	38,760	39,704	41,173	42,173	42,757	43,941	47,173
Bayfield	1,090	13,922	1,153	1,225	1,335	1,422	1,525	1,545	1,555	1,552	1,549	1,705
Durango	12,439	669	12,927	12,993	13,103	13,103	13,350	13,278	13,468	13,731	13,922	15,628
Ignacio	720	27,801	729	709	693	693	706	709	701	682	669	754
Unincorporated	18,035	3.5	19,620	20,671	23,542	23,542	24,123	24,786	25,449	26,792	27,801	29,086
Municipal Population Shares Percent												
Bayfield	3.4	31.7	3.3	3.4	3.6	3.7	3.8	3.8	3.8	3.6	3.5	3.6
Durango	38.5	1.5	37.5	36.5	35.5	33.8	33.6	32.9	32.7	32.1	31.7	33.1
Ignacio	2.2	63.3	2.1	2.0	1.9	1.8	1.8	1.8	1.7	1.6	1.5	1.6
Unincorporated	55.9	43,941	56.7	58.1	59.0	60.7	60.7	61.5	61.8	62.7	63.3	61.7
Change in County Population with Components of Change												
La Plata County	32,284	33,411	34,429	35,598	36,906	38,760	39,704	40,318	41,173	42,757	43,941	47,173
Net Change	-	1,184	1,018	1,169	1,308	1,854	944	614	855	1,584	1,184	3,232
Percent Change	-	2.8	3.0	3.4	3.7	5.0	2.4	1.5	2.1	3.8	2.8	7.3
Births	-	-	413	413	479	404	410	464	417	455	437	-
Deaths	-	-	201	231	220	245	224	249	231	248	241	-
Net Natural Increase	-	-	212	182	259	159	186	215	186	207	196	-
Net Migration[1]	-	-	806	987	1,049	1,695	758	399	669	1,377	1,298	-

Note:
1. Net migration computed by subtracting net natural increase from net change.
Sources: CDOLA 2002d, 2005a

Table 3-148 Population Estimates for Archuleta County, Colorado, 1990–2004

Parameter/Location	Date											Jul-04
	Apr-90	9,898	Jul-92	Jul-93	Jul-94	Jul-95	Jul-96	Jul-97	Jul-98	Jul-99	Apr-00	
County and Municipal Populations												
Archuleta County	5,345	1,591	5,880	6,177	6,539	7,108	7,928	8,534	9,133	9,570	9,898	11,464
Pagosa Springs	1,207	16.1	1,271	1,291	1,320	1,362	1,513	1,587	1,605	1,597	1,591	1,620
Municipal Population Shares Percent												
Pagosa Springs	22.6	9,898	21.6	20.9	20.2	19.2	19.1	18.6	17.6	16.7	16.1	14.1
Change in County Population with Components of Change												
Archuleta County	5,345	328	5,880	6,177	6,539	7,108	7,928	8,534	9,133	9,570	9,898	11,464
Net Change	-	3.4	254	297	362	569	820	606	599	437	328	1,566
Percent Change	-	-	4.5	5.1	5.9	8.7	11.5	7.6	7.0	4.8	3.4	15.8
Births	-	-	70	61	76	60	75	96	99	82	104	-
Deaths	-	-	26	36	36	36	35	39	48	41	56	-
Net Natural Increase	-	-	44	25	40	24	40	57	51	41	48	-
Net Migration[1]	-	-	210	272	322	545	780	549	548	396	410	-

Note:
1. Net migration computed by subtracting net natural increase from net change.
Sources: CDOLA 2002d, 2005a

Table 3-149 Population Estimates for the State of Colorado, 1990–2004

Parameter/Location	Date											
	Apr-90	Jul-91	Jul-92	Jul-93	Jul-94	Jul-95	Jul-96	Jul-97	Jul-98	Jul-99	Apr-00	Jul-04
Population	3,304,041	3,380,951	3,489,833	3,605,043	3,712,065	3,811,077	3,902,451	3,995,924	4,102,491	4,215,984	4,301,261	4,653,023
Net Change	-	76,910	108,882	115,210	107,022	99,012	91,374	93,473	106,567	113,493	85,277	351,762
% Change	-	2.3	3.2	3.3	3.0	2.7	2.4	2.4	2.7	2.8	2.0	8.2
Births	-	-	54,156	54,269	54,028	54,176	54,943	55,933	57,823	60,641	63,917	-
Deaths	-	-	22,480	23,083	23,951	24,523	25,221	25,517	25,991	26,737	26,998	-
Net Natural Increase	-	-	31,186	30,077	29,653	29,722	30,416	30,416	31,832	33,904	36,919	-
Net Migration	-	-	77,696	85,133	77,369	69,290	60,958	63,057	74,735	79,589	74,288	-

Note:

1. Net migration computed by subtracting net natural increase from net change.

Sources: CDOLA 2002d, 2005a

Population Trends

Overall, the State of Colorado experienced high population growth over the last decade. In addition, the population is projected to continue to increase, although at a much slower rate. As shown in Table 3-150, the total state population is projected to increase at an annual rate of 1.99 percent over the next 20 years, compared with the average annual rate of 2.7 percent during the 1990s (Table 3-149). Similarly, the population of La Plata County grew at an annual rate of 3.1 percent from 1990 to 2000 and is projected to increase by 1.7 percent annually from 2000 to 2025. The population of Archuleta County is projected to grow more slowly from 2000 to 2025 compared to the growth from 1990 to 2000, but the projected 3.26 percent average annual increase in population is significantly higher than the projected growth in population for the state and region.

Table 3-150 Population Projections for La Plata County, Archuleta County, and the State of Colorado, 2000–2025

	Population by Location			
Year	La Plata County	Archuleta County	Region 9 Planning Area[1]	Colorado
2000	44,183	9,952	80,511	4,324,919
2001	44,415	10,540	82,801	4,406,267
2002	45,626	11,039	85,102	4,488,405
2003	46,829	11,535	87,406	4,568,515
2004	48,026	12,030	89,715	4,648,371
2005	50,150	12,441	92,032	4,733,167
2010	55,839	14,922	103,426	5,170,938
2015	60,837	17,394	113,744	5,617,933
2020	64,105	19,842	123,077	6,067,413
2025	67,378	22,199	131,710	6,523,992
Average Annual Growth (percent change)	1.70	3.26	1.66	1.99

Note:
1. Region 9 Planning Area includes Archuleta, Dolores, La Plata, Montezuma, and San Juan Counties.

Source: CDOLA 2002c

Household Information

Across the state and in both La Plata and Archuleta Counties, the average number of persons per household decreased by less than one percent from 1990 to 2004. The changes in persons per household in La Plata and Archuleta Counties and for the State of Colorado from 1990 to 2004 are summarized in Table 3-151. In 1990, the number of persons per household in both counties was higher than the statewide average. By 2004, conversely, the number of persons per household in La Plata and Archuleta Counties was lower than for the state as a whole.

Racial and Ethnic Composition and Demographics

As indicated in Table 3-152, the racial composition of the State of Colorado is comparable to that of La Plata and Archuleta Counties. In 2000, the minority population in the state was 17.1 percent and was 12.8 percent in La Plata County and 11.7 percent in Archuleta County. Native American populations were

5.8 percent in La Plata County and 1.4 percent in Archuleta County, compared with the overall 1 percent for the state. Black and Asian populations are much lower in these two counties than statewide. Based on the 2000 Census, 10.4 percent of the population of La Plata County and 16.8 percent of the population of Archuleta County was Hispanic; lower than the state as a whole (17.1 percent).

Table 3-151 Summary of Household Information, 1990–2004

	Households			Persons per Household		
Area	1990	2000	2004	1990	2000	2004
Colorado	1,285,119	1,658,238	1,786,882	2.56	2.59	2.54
La Plata County	11,963	17,342	18,796	2.70	2.53	2.43
Archuleta County	2,023	3,980	4,613	2.64	2.49	2.47

Sources: U.S. Census 1990b, 2000a; CDOLA 2005b

Table 3-152 Racial and Ethnic Composition for La Plata County, Archuleta County, and State of Colorado

	1990		2000		
Category	Number	Portion (percent)	Number	Portion (percent)	Percent Change 1990–2000
La Plata County					
One Race					
White	29,022	89.9	38,364	87.3	32.2
Black	71	0.2	136	0.3	91.5
Native American	1,602	5.0	2,539	5.8	58.5
Asian	171	0.5	177	0.4	3.5
Pacific Islander	8	0.0	24	0.1	200.0
Other	1,410	4.4	1,712	3.9	21.4
Two or more races			989	2.3	
Hispanic (of any race)	3,586	11.1	4,571	10.4	
Archuleta County					
One Race					
White	4,664	87.3	8,743	88.3	87.5
Black	7	0.1	35	0.4	400.0
Native American	107	2.0	139	1.4	29.9
Asian	28	0.5	31	0.3	10.7
Pacific Islander	1	0.0	3	0.0	200.0
Other	538	10.1	690	7.0	28.3
Two or more races			257	2.6	
Hispanic (of any race)	1,244	23.3	1,659	16.8	
Colorado					
One Race					
White	2,905,474	88.2	3,560,005	82.8	22.5
Black	133,146	4.0	165,063	3.8	24.0
Native American	27,776	0.8	44,241	1.0	59.3
Asian	57,122	1.7	95,213	2.2	66.7
Pacific Islander	2,740	0.1	4,621	0.1	68.6
Other	168,136	5.1	309,931	7.2	84.3
Two or more races			122,187	2.8	
Hispanic (of any race)	424,302	12.9	735,601	17.1	73.4

Source: U.S. Census 1990a, 2000a

The population demographics for La Plata and Archuleta Counties and the State of Colorado for 1990 and 2000 are shown in Table 3-153. The age structure of the populations in both counties is comparable to the State of Colorado and to the country as a whole. The middle age group of the population (35 to 64) grew from 1990 to 2000, whereas the youngest age class decreased, which is consistent with the aging of the general population.

Table 3-153 Population Demographics for La Plata County, Archuleta County, and State of Colorado

Area/Parameter	Age Class			
	<5 to 34	35 to 64	65 to 85>	Total
La Plata County				
1990				
Population	17,840	11,224	3,220	32,284
Percent of 1990 Total	55	35	10	
2000				
Population	21,651	18,162	4,128	43,941
Percent of 2000 Total	49	41	10	
Archuleta County				
1990				
Population	2,633	2,091	621	5,345
Percent of 1990 Total	49	39	12	
2000				
Population	4,069	4,651	1,178	9,898
Percent of 2000 Total	41	47	12	
Colorado				
1990				
Population	1,808,640	1,156,311	329,443	3,294,394
Percent of 1990 Total	55	35	10	
2000				
Population	2,194,933	1,690,255	416,073	4,301,261
Percent of 2000 Total	51	39	10	

Source: U.S. Census 1990b, 2000a

3.15.2.1.2 Employment

Trends in La Plata and Archuleta Counties for employment, unemployment, and wages are similar to trends statewide as shown on Table 3-154. Both counties and the state experienced dramatic increases in the labor force from 1990 to 2003. In addition, the services category, including agricultural services, is the largest employment sector in the counties, as well as for the state.

The number of employed workers grew faster than the total labor force for the State of Colorado in the 1990s, resulting in a reduction in unemployment from 1990 to 1999. However, the statewide unemployment rate increased from 4 percent in 1999 to 6 percent in 2003. The 2003 unemployment rate of 5 percent in La Plata County was less than the Archuleta County and statewide rates of 6 percent as shown on Table 3-154.

Employment Activity by Business Sector

Basic economic activity may be direct or indirect. Direct basic employment and income are generated when an industry exports goods and services or attracts expenditures from other outside sources, such as tourists. Indirect basic industries

supply goods and services to the direct basic industries. Direct and indirect basic employment generates additional employment because of the goods and services that resident employee's demand of local businesses. The local economic base consists of industries that bring in dollars from outside the regional economy. Basic income and employment in the Project Area result from various local industries.

Table 3-154 Resident Labor Force, Employment, and Unemployment for La Plata County, Archuleta County, and State of Colorado, 1990–2003

Category	1990	1995	1999	2003
La Plata County				
Labor Force	17,399	23,123	24,175	26,799
Unemployed	1,009	1,080	926	1,263
Unemployment Rate	6%	5%	4%	5%
Archuleta County				
Labor Force	2,682	3,581	4,561	5,329
Unemployed	135	172	177	306
Unemployment Rate	5%	5%	4%	6%
Colorado				
Labor Force	1,764,181	2,087,524	2,264,105	2,477,874
Unemployed	89,057	87,499	65,958	149,692
Unemployment Rate	5%	4%	3%	6%

Source: CDOLA 2002a, 2005c

In La Plata County, direct basic activities account for 43 percent of all employment, generating more than 13,000 jobs (Region 9 EDD 2003). Although it is not a specific industrial category, tourism is considered a wholly direct basic activity, because it consists of expenditures from outside visitors. Tourism itself is a collection of other sectors, such as retail trade and services, hotel, lodging, and eating-and-drinking establishments. Tourism is the largest basic industry employer in the county, accounting for more than 8,000 jobs and resulting in 62 percent of direct basic employment (Region 9 EDD 2003). In comparison, agricultural production and services generate 4.7 percent of total direct basic employment, and oil and gas extraction results in 1.9 percent of total direct basic employment (Region 9 EDD 2003). In La Plata County, almost three-quarters of agricultural employment is defined as a direct basic employment sector; however, oil and gas extraction is wholly a direct basic employment sector.

The income these industries generate is not directly proportional to the employment percentages. For example, jobs in the agricultural and service sectors are lower paying; therefore, these sectors contribute less to total income than do higher-paying jobs in other sectors. In addition, tourism provides 62 percent of the direct basic employment but accounts for only 35.7 percent of all direct basic income (Region 9 EDD 2003). In contrast, oil and gas extraction accounts for more income, compared with its share of employment. Oil and gas extraction contributes 3.6 percent of direct basic income in La Plata County but only 1.9 percent of total direct basic employment (Region 9 EDD 2003).

The largest job sector from 1990 to 2003 in La Plata County was the services industry, including agricultural services, which represented 31 percent of the jobs

in the county in 2003. Construction and retail trade, financial services, insurance and real estate were the only other sectors that accounted for more than 10 percent of the jobs (Table 3-155). Jobs related to oil and gas extraction are included in the mining category. In 2003, the mining sector represented one percent of the jobs in La Plata County.

Table 3-155 Employment and Earnings by Place of Work for La Plata County, 1990–2003

Category	1990	1995	1999	2003
Full and Part Time Jobs				
Farm	903	857	833	940
Mining	324	432	332	458
Construction	1,741	2,626	3,090	3,420
Manufacturing	689	1,017	1,072	798
Transportation & Public Utilities	706	845	982	760
Wholesale Trade	522	723	826	NA[1]
Retail Trade	3,734	5,528	6,130	7,271
Financial Services, Insurance and Real Estate	1,451	2,047	2,617	958
Services, Including Agricultural Services	6,687	9,744	11,069	2,773
Government	3,218	3,480	3,814	5,214
Total Employees	19,975	27,299	30,765	32,989
Percent by Sector (Column %)				
Farm	4.5	3.1	2.7	2.8
Mining	1.6	1.6	1.1	1.4
Construction	8.7	9.6	10.0	10.4
Manufacturing	3.4	3.7	3.5	2.4
Transportation & Public Utilities	3.5	3.1	3.2	2.3
Wholesale Trade	2.6	2.6	2.7	NA
Retail Trade	18.7	20.2	19.9	22.0
Financial Services, Insurance and Real Estate	7.3	7.5	8.5	8.4
Services, Including Agricultural Services	33.5	35.7	36.0	31.2
Government	16.1	12.7	12.4	0.6
Total Employees	100.0	100.0	100.0	100.0

Note:
1. NA = Not Available
Sources: Bureau of Economic Analysis 2003, 2005a

The largest job sector in Archuleta County from 1990 to 2003 was the services industry, including agricultural services, which represented 23 percent of the jobs in the county in 2003. Retail trade accounted for 22 percent of the jobs; construction and financial services, insurance, and real estate were the only other sectors with more than 10 percent of the jobs (Table 3-156). In 2003, the mining sector represented less than one percent of the jobs in Archuleta County.

Similar trends were evident for the State of Colorado from 1990 to 2003, as shown in Table 3-157. In 2003, the mining sector represented less than one percent of the jobs statewide.

Table 3-158 shows employment and earning in oil and gas from 1995 to 2003. Total statewide employment in oil and gas extraction diminished from 1995 to 2001, falling more than 50 percent. Fewer people in La Plata County were employed in the oil and gas industry from 1999 to 2003 than in 1995. In contrast, employment in oil and gas grew during the first half of the 1990s.

Table 3-156 Employment and Earnings by Place of Work for Archuleta County, 1990–2003

Category	1990	1995	1999	2003
Full and Part Time Jobs				
Farm	215	229	245	259
Mining	34	51	52	63
Construction	87	533	935	1,106
Manufacturing	72	91	118	79
Transportation & Public Utilities	67	96	110	95
Wholesale Trade	13	27	60	69
Retail Trade	525	867	1,201	1,490
Financial Services, Insurance, and Real Estate	268	490	894	958
Services, Including Agricultural Services	1,094	1,351	1,652	1,514
Government	409	455	550	662
Total Employees	2,784	4,190	5,817	6,693
Percent by Sector (Column %)				
Farm	7.6	6.0	4.5	3.9
Mining	1.0	1.1	0.9	0.9
Construction	3.2	9.8	15.2	16.5
Manufacturing	2.8	3.3	2.0	1.2
Transportation & Public Utilities	3.4	3.1	2.3	1.4
Wholesale Trade	0.2	0.5	1.2	1.0
Retail Trade	19.7	21.5	20.1	22.3
Financial Services, Insurance, and Real Estate	10.1	11.5	15.2	14.3
Services, Including Agricultural Services	38.6	31.7	29.2	22.6
Government	13.3	11.4	9.5	3.2
Total Employees	100.0	100.0	100.0	100.0

Sources: Bureau of Economic Analysis 2003, 2005a

The oil and gas industry has traditionally been an important source of employment in southern Colorado. Employment and earnings from the oil and gas extraction sector from 1995 to 2003 are shown in Table 3-158. The number of people in La Plata County employed in the oil and gas industry fell between 1995 and 2001; however, total earnings increased, resulting in a dramatic rise in per capita earnings. The 1999 per capita earnings for people employed in the oil and gas industry in La Plata County were more than 200 percent higher than in 1995. Statewide earnings for employees in the oil and gas industry increased more than 150 percent during the 1990s. Although these increases in per capita earnings were significant, they represent a small share of the total earnings in La Plata County. Employees in the oil and gas industry account for only about 2.5 percent of all earnings in the county (Colorado Department of Labor and Employment [CDOLE] 2005).

Data on employment in the oil and gas extraction sector was not available for Archuleta County; however, there were 63 employees in the mining sector in 2003 (Bureau of Economic Analysis 2005a). A portion of these employees was in oil and gas extraction.

Table 3-157 Employment and Earnings by Place of Work for the State of Colorado, 1990–2003

Category	1990	1995	1999	2003
Full and Part Time Jobs				
Farm	43,690	39,739	44,360	31,986
Mining	31,384	25,831	22,076	21,323
Construction	97,386	149,956	206,579	219,080
Manufacturing	197,879	205,233	217,141	167,939
Transportation & Public Utilities	107,235	130,759	157,743	88,569
Wholesale Trade	92,254	106,194	116,854	101,702
Retail Trade	344,149	434,124	478,687	526,815
Financial Services, Insurance, and Real Estate	179,826	208,084	280,864	302,094
Services, Including Agricultural Services	628,547	795,071	948,643	1,035,511
Government	332,420	353,129	373,321	406,228
Total Employees	2,054,770	2,448,120	2,846,268	2,928,209
Percent by Sector (Column %)				
Farm	2.1	1.6	1.6	1.1
Mining	1.5	1.1	0.8	0.7
Construction	4.7	6.1	7.3	7.5
Manufacturing	9.6	8.4	7.6	5.7
Transportation & Public Utilities	5.2	5.3	5.5	3.0
Wholesale Trade	4.5	4.3	4.1	3.5
Retail Trade	16.7	17.7	16.8	18.0
Financial Services, Insurance, and Real Estate	8.8	8.5	9.9	10.3
Services, Including Agricultural Services	30.6	32.5	33.3	35.4
Government	16.2	14.4	13.1	13.9
Total Employees	100.0	100.0	100.0	100.0

Sources: Bureau of Economic Analysis 2003, 2005a

Table 3-158 Employment and Earnings in Oil and Gas Extraction, 1990–2004

Category	1995	1999	2000	2001	2002	2003	2004
Colorado							
Employment	8,699	6,937	7,286	3,734	3,876	4,124	4,304
Average Wage ($)	49,265	64,007	69,174	119,808	81,744	93,392	141,856
La Plata County							
Employment	206	121	143	103	NA[1]	163	192
Average Wage ($)	36,584	55,391	58,244	79,352	NA	84,032	100,256

Notes:
1. No data available for Archuleta County.
Sources: CDOLE 2005

Employment Trends and Projections

From 2000 to 2025, employment is projected to increase for both La Plata and Archuleta Counties (Table 3-159). There were 54 percent more jobs in La Plata County in 2005 than in 1990. There were 44 percent more jobs in 2005 in Archuleta County, compared with 1990. Although this pace of growth in employment is not expected to continue, both counties are projected to see continued expansion of the employment base (Table 3-159).

Table 3-159 Projected Employment and Commuting Patterns to 2025 for La Plata and Archuleta Counties

Area	1990	1995	2000	2005	2010	2015	2020	2025
La Plata County								
Total Jobs	19,191	26,260	30,811	35,630	40,993	45,324	49,947	53,803
Commuting Out	833	850	900	925	950	975	1,000	1,025
Commuting In	1,623	4,150	5,559	6,710	8,412	10,041	12,682	15,468
Difference	-790	-3,300	-4,659	-5,785	-7,462	-9,066	-11,682	-14,443
Archuleta County								
Total Jobs	2,724	3,611	5,222	6,128	7,097	7,843	8,629	9,283
Commuting Out	332	489	900	1,850	6,295	8,218	10,047	12,760
Commuting In	175	125	132	346	4,050	5,050	6,050	8,050
Difference	157	364	768	1,504	2,245	3,168	3,997	4,710

Source: CDOLA 2002d

Throughout the 1990s, more workers commuted into La Plata County than commuted out (Table 3-159). Furthermore, projections for employment indicate that La Plata County will continue to be a large net importer of employees through the year 2025. In contrast, Archuleta County was a net exporter of employees in the 1990s, because more employees commuted out of the county than into it (Table 3-159). Although Archuleta County's employment base is also projected to grow through the year 2025, its workforce may grow at a higher rate. This trend indicates that residents of Archuleta County will continue to commute to other counties to work.

Table 3-160 shows the average per capita income, median household income, and estimated portion of residents living below the poverty line for La Plata and Archuleta Counties and the state. Based on the 1990 and 2000 Census data, the portions of residents in La Plata and Archuleta Counties living below the poverty line were greater than the Colorado statewide average. In 1990, the portions of residents in the two counties living below the poverty line were about 33 percent higher than the statewide average (Table 3-160). By 1999 to 2000, the portions of residents living below the poverty line had decreased in both counties and statewide. Although the portion of residents living below the poverty line in La Plata County relative to the statewide average declined from 1990, the portion in Archuleta County relative to the statewide average increased (Table 3-160). The average per capita incomes increased in 2003 for La Plata and Archuleta Counties and the state.

Table 3-160 Measures of Income and Persons below Poverty Line in Colorado and La Plata and Archuleta Counties

Area	Per Capita Income 1990 ($)	Per Capita Income 2000 ($)	Per Capita Income 2003 ($)	Median Household Income 1990 ($)	Median Household Income 2000 ($)	Portion of Persons Below Poverty 1990 (percent)	Portion of Persons Below Poverty 1999[1] (percent)
Colorado	14,602	21,600	34,561	30,172	41,659	11.7	8.9
La Plata County	11,977	17,029	29,807	25,787	35,219	15.7	10.4
Archuleta County	10,953	15,256	20,122	23,089	31,501	16.3	12.7

Note:
1. Year 1999 used because data for 2000 were not available.
Source: U.S. Census 1990c, 2000b, 2000c; Bureau of Economic Analysis 2005b

Household Income

The median household incomes in both counties have increased at roughly the same rate as the statewide average. In the year 2000, incomes for nearly 50 percent of the households in these two counties were less than $20,000. Household incomes in the year 2000 for La Plata and Archuleta Counties and the state are shown in Table 3-161.

Table 3-161 Households by Income for La Plata and Archuleta Counties, and Colorado, 2000

Households by Income	La Plata County		Archuleta County		Colorado	
	Households	Percent	Households	Percent	Households	Percent
Less than $5,000	837	5.4	180	4.8	65,290	4.1
$5,000 to $9,999	1,067	6.9	369	9.9	89,298	5.6
$10,000 to $14,999	838	5.4	229	6.1	67,096	4.2
$15,000 to $19,999	1,636	10.6	399	10.7	127,098	7.9
$20,000 to $24,999	1,164	7.5	282	7.5	105,636	6.6
$25,000 to $29,999	1,154	7.4	313	8.4	106,345	6.6
$30,000 to $34,999	996	6.4	333	8.9	90,865	5.7
$35,000 to $39,999	1,308	8.4	256	6.8	125,332	7.8
$40,000 to $49,999	1,517	9.8	309	8.3	149,802	9.3
$50,000 to $59,999	1,309	8.4	288	7.7	162,099	10.1
$60,000 to $74,999	1,196	7.7	286	7.6	188,502	11.8
$75,000 to $99,999	1,237	8.0	225	6.0	175,743	11.0
$100,000 to $124,999	509	3.3	135	3.6	71,317	4.4
$125,000 to $149,999	309	2.0	45	1.2	29,210	1.8
$150,000 and over	422	2.7	95	2.5	50,053	3.1
Total	15,499		3,744		1,603,686	

Source: U.S. Census 2000b

3.15.2.2 Housing

Housing is generally available in the Project Area in both counties. The number of housing units, households, building units, and vacant housing units for La Plata and Archuleta Counties between 1995 and 2004 is shown in Table 3-162 and Table 3-163.

In 2004, over 7,800 housing units were vacant in La Plata and Archuleta Counties (Table 3-162 and Table 3-163). The vacancy rate was 21 percent in La Plata County and 38 percent in Archuleta County (CDOLA 2005a).

Some of the vacant housing is attributable to second homes used for recreation or vacation (or rented for recreation or vacation) and to vacant housing units sold. In 2000, 102 of the 5,819 total housing units in Durango were seasonal (CDOLA 2005d). Part-time residents account for 35 percent of the households in Archuleta County (Archuleta County 2001).

Some of the housing units in La Plata County are rentals: apartments, condominiums, and single-family homes. In 2001, there were an estimated 9,000 rental units in La Plata County (Holmes 2001). Monthly rents range from $450 for a studio or one-bedroom apartment to more than $1,500 for a single-family home (Holmes 2001). For the first quarter of 2005, there was a vacancy rate of 4.2 per-

cent for the 1,867 multifamily housing rental units in Durango and average monthly rent was $732 (CDOLA 2005e).

Table 3-162 Housing and Vacant Housing in La Plata County, 1995–2004

	Year									
Housing	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Housing Units	17,755	19,237	19,768	20,233	20,747	20,765	21,837	20,480	23,024	23,815
Net Building Permits[1]	643	514	465	514	NA[2]	433	552	516	NA	NA
Total Households	14,316	14,979	14,316	14,979	15,976	17,342	18,139	18,423	18,629	18,796
Vacant Units[3]	3,439	4,258	4,444	4,517	4,771	3,423	3,698	4,057	4,367	5,019

Notes:
1. Building permits include both private and public new housing units; data prior to 1995 subtracted demolitions. In most cases, the permits do not cover mobile homes or trailers.
2. NA = Not available.
3. Vacant housing units are computed by subtracting total households from total housing units. Households (total occupied housing units) are estimated from total housing units, household population, and persons per household.

Source: CDOLA 2001a, 2005a, 2005b.

Table 3-163 Housing, Households, Building Permits, and Vacant Housing in Archuleta County, 1993–2004

	Year									
Housing	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Housing Units	4,483	4,731	4,980	5,223	5,536	6,212	6,572	6,864	7,240	7,459
Net Building Permits[1]	248	249	243	308	271	360	292	376	NA[2]	NA
Total Households	2,671	2,987	3,239	3,452	3,619	3,980	4,243	4,390	4,505	4,614
Vacant Units[3]	1,812	1,744	1,741	1.771	1,917	2,232	2,329	2,474	2,735	2,845

Notes:
1. Building permits include both private and public new housing units; data for years before 1995 subtracted demolitions. In most cases, the permits do not cover mobile homes or trailers.
2. NA = Not available.
3. Vacant housing units are computed by subtracting total households from total housing units and include both seasonal and vacant units. Households (total occupied housing units) are estimated from total housing units, household population, and persons per household.

Source: CDOLA 2001a, 2005a, 2005b

The vacancy rate for rental housing fluctuates, but suggests that rental housing is in short supply overall. In 2000, the vacancy rate for rental housing was 1.4 percent for the first quarter but 6.2 percent for the third quarter (CDOLA 2003e). The vacancy rate for rental housing in La Plata County had dropped to 2.9 percent for the first quarter of 2001. This tight rental market appears primarily to be attributable to the following factors:

- Demand created by students at Fort Lewis College,
- Employees in the tourism- and recreation-based economy, and
- Positive net migration that is likely contributing to high occupancy of rental homes.

In addition to rental housing, mobile homes are available in La Plata County. As of June 2001, La Plata County had 51 mobile home parks with a total of 1,382 pads (Larson 2001). Most of the mobile home parks are small (70 percent have fewer than 30 pads).

3.15.2.3 Facilities, Services, and Infrastructure

Development of CBM has the potential to affect existing community facilities, services, and infrastructure. The use of existing facilities or infrastructure, including roads and bridges, may affect the capacity of service agencies or transportation systems or may require new facilities. Growth in population and employment may also affect local-community facilities, services, and infrastructure in the Project Area. The following sections characterize existing country road and bridge facilities, public services, and general-government services in La Plata and Archuleta Counties.

3.15.2.3.1 County Road and Bridge

Most of the county roads in the Project Area are in La Plata County. About 173 miles of the total 600 miles of county roads in La Plata County are paved. Another 485 miles of county roads are gravel (La Plata County 2002a). The Project Area does not contain any roads maintained by Archuleta County. Most land in the Archuleta County portion of the Project Area is within the Columbine Ranger District of the SJNF. Therefore, with the exception of U.S. Highway 160 and State Route 151, roads in the Project Area in Archuleta County are NFSRs maintained by the SJNF.

From 1997 to 2004, expenditures by the La Plata County Road and Bridge Department over 70 percent. Expenditures increased from $8.9 million in 1997 to $12.6 million in 2004 (La Plata County 2005). Capital expenditures and improvements on roads and bridges account for most of the increased expenditures.

3.15.2.3.2 Public Services

The local-government services that the proposed project may affect are law enforcement, emergency response, utilities (power and water), hospitals, and schools. A summary of the local-government services for La Plata and Archuleta Counties is displayed in Table 3-164 and discussed in this section.

The two fire districts that serve the portion of the Project Area in La Plata County are the Durango Fire and Rescue Authority and the Upper Pine Fire Protection District (La Plata County 1999). The Upper Pine Fire Protection District serves most of the eastern portion of La Plata County, including the Town of Bayfield.

The City of Durango provides water to the incorporated and adjacent unincorporated areas (City of Durango 1997). The city's water is supplied from the Florida and Animas Rivers. The Durango Fire and Rescue Authority provides fire protection and emergency medical services in the Durango planning area outside the city limits, including the northwestern portion of the Project Area.

Table 3-164 Summary of Local-Government Services for La Plata and Archuleta Counties

Service	Description
Law Enforcement	**La Plata County** Law enforcement is provided by a combination of municipal and county agencies, including the following: City of Durango Police Department (staff of 52) City of Bayfield Police Department (staff of six with four vehicles) La Plata County Sheriff's Department (staff of 113 in 2004) **Archuleta County** Law enforcement is provided by a combination of municipal and county agencies, including the following: Archuleta County Sheriff's Office (staff of 29) Pagosa Springs Police Department (staff of nine and eight vehicles)
Education	**La Plata County** Schools are administered through three districts: Durango School District (seven elementary, two middle, one high school) Bayfield School District (one elementary, one middle, one high school) Ignacio School District (one elementary [K-4], one intermediate [5-6], one junior and one senior high school) **Archuleta County** Schools are administered through the Archuleta School District-joint 50, which has one elementary (K-4), one intermediate (5-6), one junior, and one senior high school serving the entire county.
Fire/ Ambulance	**La Plata County** Fire and medical response services are provided by a combination of municipal and county agencies, including the following: Durango Fire and Rescue Authority (staff of 52) Upper Pine Fire Protection District/Department (includes Bayfield) **Archuleta County** Fire and medical response services are provided by a combination of municipal and county agencies, including the following: Pagosa Fire Protection District/Fire Department Upper San Juan Hospital District provides ambulance service
Hospitals	**La Plata County** Mercy Medical Center serves all surrounding towns in and outside La Plata County. San Juan Basin Health provides additional care, and Four Corners Nursing Home (156 beds) provides care for the elderly. Numerous dental, physician, therapist, and optometrist practices in Durango serve the region. **Archuleta County** Upper San Juan Hospital district includes an EMS facility for emergency treatment and a family practice and associated clinic for outpatient treatment. In-patient services are provided by Mercy Medical Center of Durango.
Utilities	La Plata Electric Association (LPEA) is a rural electric provider serving both Archuleta and La Plata Counties. Serving 33,321 customers in 2000, the utility has seen a rise from 107 to 143 megawatts (MW) in peak demand and produces power at a cost of $0.0347 per kilowatt-hour. Citizens Other utilities provide natural gas in incorporated areas in La Plata and Archuleta Counties. Propane is provided by numerous businesses such as Arrow Gas and Mesa Propane in La Plata County and Columbia Propane or Ferrell Gas in Archuleta County. Water is supplied to incorporated areas of La Plata County by the City of Durango and to incorporated areas of Archuleta County by the Pagosa Area Water and Sanitation District

Source: BBC Research and Consulting 2001a; La Plata County 2004a

Fire protection in the unincorporated portion of Archuleta County is offered in part by the Pagosa Fire Protection District. Under cooperative agreements, the FS

and Colorado State Forest Service assist in firefighting in forested areas of the county.

3.15.2.3.3 General Government

The La Plata County Planning Services Department is responsible for permitting land development in La Plata County, including oil and gas. The department reviewed 33 applications for oil and gas development projects in 1997 (Keller 2001). In 2004, the department reviewed 84 applications for oil and gas development and a total of 330 applications for land-use permits of all kinds (Lauro 2005). The number of oil- and gas-related permit applications reviewed per year is expected to double in 2006 and triple in 2007 (Lauro 2005).

Other general-government units in La Plata County that would be affected by or that exercise jurisdiction over aspects of oil and gas development are County Administrative Services (negotiating impact-mitigation measures), the Board of County Commissioners (conflict resolution), the Assessor's Office (reporting royalty interest), and the County Attorney (negotiation and litigation).

3.15.2.4 Fiscal Conditions of Local Government

La Plata and Archuleta Counties receive revenues from development of oil and gas in a variety of ways. The most important source of revenue related to oil and gas development is the *ad valorem* property tax on production and field equipment. These taxes are levied on the assessed value of natural gas produced during the previous year, as well as on the treatment and transmission facilities and other real property involved in production of gas. Other potential sources for county revenue that are attributed to production of natural gas include redistribution of severance-taxes grants from the Colorado Energy and Mineral Impact Assistance Fund and distribution of rental and royalty fees collected by the U.S. Department of the Interior for development of federally owned minerals.

The analysis of county revenues paid by the oil and gas industry focuses primarily on La Plata County because there are many more producing wells in La Plata County compared to Archuleta County. The 2002 oil and gas production value for La Plata County was $1,178 million compared to $3 million in Archuleta County (COGCC 2005). In 2004, there were 2,351 producing gas wells in La Plata County compared to 29 in Archuleta County (COGCC 2005).

3.15.2.4.1 Assessed Valuation

The county assessor assigns a taxable value to all real or personal property in the county as a basis for generating property tax revenues. The actual value of a property is not the taxable value. Rather, the assessed value is a percentage of the actual value of the property.

The assessed value for producing oil and gas properties is based on the earnings from production. The counties and other special tax districts classify the value of production as real property for properties with producing gas wells, regardless of surface or mineral ownership. The assessed value for producing oil and gas leaseholds and lands is 87.5 percent of the average wellhead price of the oil and gas sold or transported from the premises of primary recovery during the preceding calendar year.

The total assessed valuation is the sum of the assessed values for all properties in the county and is a measure of the tax base. The total assessed valuation for real and personal property in La Plata County is shown in Table 3-165. The total assessed valuation in La Plata County increased substantially between 1993 and 2004. Both production from existing oil and gas wells and construction of additional residential and commercial properties have contributed to the increase in the total assessed valuation of the county. Therefore, the tax base has increased since 1993.

Table 3-165 Share of Total Assessed Value Attributable to Oil and Gas in La Plata County, 1993–2004

Year	Total Assessed Valuation ($)	Oil and Gas Portion ($)	Share From Oil and Gas (percent)
1993	516,832,600	164,736,070	31.9
1994	624,804,060	239,470,550	38.3
1995	752,063,090	302,840,090	40.3
1996	706,256,580	241,082,400	34.1
1997	918,132,090	368,385,670	40.1
1998	1,125,640,730	561,742,810	49.9
1999	1,163,142,350	527,451,100	45.4
2000	1,211,254,190	554,475,990	45.8
2001	1,738,495,890	1,032,567,880	59.3
2002	1,872,066,280	1,146,165,110	61.2
2003	1,518,735,250	728,490,780	48.0
2004	2,130,538,680	1,321,389,610	62.0

Source: CDOLA 2003b; Larson 2005

Oil and gas properties account for a substantial portion of the county tax base in La Plata County. Table 3-165 shows the total assessed valuation compared with the valuation of all oil and gas properties and the portion of the tax base attributable to oil and gas properties. The assessed valuation for all oil and gas properties has consistently exceeded 30 percent of the total in La Plata County and, more recently, has ranged between 45 and 60 percent.

Most of the assessed valuation that is attributable to oil and gas properties in La Plata County is from production of natural gas. As shown in Table 3-166, the assessed value of natural-gas production and equipment has represented at least 99 percent of the total assessed valuation for minerals in La Plata County for each year from since 1993 to 2004.

3.15.2.4.2 Ad Valorem Property Taxes

Property tax collections represent a significant portion of total annual revenues for both La Plata and Archuleta Counties. The total assessed valuation, total property tax revenues, and total county revenues for La Plata County are shown in Table 3-167. As shown in the table, revenues from property taxes have represented between 19 and 46 percent of total annual revenues to the county since 1993.

Table 3-166 Share of Total Mineral Assessment Attributable to Natural Gas in La Plata County, 1993-2004

Year	Total Mineral Value ($)	Total Gas Value ($)	Share Gas (percent)
1993	104,487,840	102,992,210	98.6
1994	172,136,850	171,012,960	99.3
1995	216,865,180	215,821,520	99.5
1996	155,005,810	153,872,520	99.3
1997	368,938,150	366,993,190	99.5
1998	562,291,650	560,394,800	99.7
1999	524,451,270	522,723,310	99.7
2000	550,936,430	548,775,030	99.6
2001	1,035,524,143	1,032,567,880	99.7
2002	1,149,082,950	1,146,165,110	99.7
2003	731,139,990	728,490,780	99.6
2004	1,324,003,820	1,321,389,610	99.8

Source: Larson 2005

Table 3-167 Total Property Assessments, Taxes Levied, and Share of Total La Plata County Revenues, 1993-2004

Year	Total Assessed Valuation ($000s)	Mill Levy	Property Tax Revenues ($)	La Plata County Total Revenues ($)	Property Tax Revenue Share (percent)
1993	516,833	8.5	3,746,908	19,343,957	19.4
1994	624,804	8.5	4,414,226	22,120,020	20.0
1995	752,063	8.5	5,283,359	23,042,472	23.0
1996	706,257	8.5	6,263,075	26,843,661	23.3
1997	918,132	8.5	6,030,695	25,203,767	23.9
1998	1,125,641	8.5	7,773,789	27,109,172	28.7
1999	1,163,142	8.5	9,497,368	31,869,527	29.8
2000	1,211,254	8.5	10,295,661	36,540,222	27.2
2001	1,738,496	8.5	10,590,411	39,644,250	26.7
2002	1,872,066	8.5	11,255,557	24,570,476	45.8
2003	1,518,735	8.5	12,514,333	33,156,277	37.7
2004	2,131,539	8.5	10,561,544	31,278,891	33.8

Sources: CDOLA 2003b; Larson 2005; Verheyden 2005

Furthermore, as shown on Figure 3–72 for La Plata County, both total county revenues and total property taxes have generally increased from 1993 to 2004. In addition, both total property tax revenues and revenues from oil and gas have paralleled total county revenues in recent years.

The county levies *ad valorem* taxes for producing oil and gas properties, based on the assessed value of production in the preceding year, the number of facilities in the county, and the personal property tied to production (Hammer, Siler and George Associates 1990). The assessed value is multiplied by the mill levy to calculate the property taxes due each year. The mill levy in La Plata County has

been constant at 8.5 over the past decade and is the fourth lowest mill levy of all the counties in Colorado (La Plata County 2002a). Therefore, increases in property tax revenues from 1993 to 2004 have resulted from increased total assessed valuation in the county. Both gas production from existing wells and construction of additional residential and commercial properties have contributed to the increase in assessed valuation for the county. In addition, property values appreciated by an average of 6.9 percent per year in the 1990s (BBC Research and Consulting [BBC] 2001b).

The total assessed valuation, total property taxes, and total county revenues for Archuleta County are shown in Table 3-168. As shown in the table, revenues from property taxes have represented between 24 and 31 percent of county's total revenues since 1993. In Archuleta County, the mill levy has varied since 1997. The total assessed valuation has increased from 1993 to 2004. Therefore, both total county revenues and property tax revenues have increased over this period. In 2004, oil and gas property represented 2 percent of the total assessed valuation in Archuleta County (CDOLA 2005f).

Table 3-168 Total Assessed Valuation, Total Property Taxes, Total Archuleta County Revenues, and Share from Property Taxes

Year	Total Assessed Valuation ($000s)	Mill Levy	Property Tax Revenues ($)	Archuleta County Total Revenues ($)	Property Tax Revenue Share (percent)
1993	79,295	21.15	1,703,201	5,438,727	31.3
1994	76,706	21.15	1,631,136	5,825,447	28.0
1995	80,959	21.15	1,712,732	6,572,860	26.1
1996	86,313	21.15	1,839,067	7,067,284	26.0
1997	89,826	21.15	1,912,018	7,270,450	26.3
1998	114,592	18.03	2,050,226	8,105,384	25.3
1999	119,373	18.76	2,242,523	8,971,438	25.0
2000	149,901	16.97	2,534,834	10,638,866	23.8
2001	174,584	17.26	2,714,027	11,445,852	31.3
2002	181,921	17.61	3,032,822	11,551,489	28.0
2003	215,807	NA[1]	3,603,286	13,675,095	26.1
2004	200,080	19.75	3,949,387	14,141,321	26.0

Notes:
1. NA = Not Available
Sources: CDOLA 2003b; 2005g; La Plata County 2005; Archuleta County 2005

A large share of the total property tax revenues for La Plata County in recent years is from oil and gas property, and primarily from production of gas.

Table 3-169 shows the property tax revenues from oil and gas in La Plata County as a percentage of total property tax revenues for the years 1989 to 2004. Tax revenues from oil and gas properties have also increased from 1989 to 2004. Revenues from oil and gas as a percentage of total property tax have increased from 12 percent in 1989 to 48 percent in 2004. The growth in revenues from oil and gas results from increases in the assessed valuation of all producing gas properties. Other important sources of county revenues include residential property taxes and taxes on commercial and industrial property.

Table 3-169 Percentage of Total La Plata County Property Tax Revenues Paid by the Oil and Gas Property Taxes

Year	Total Property Tax Revenues ($)	Property Taxes Paid by Oil and Gas Industry ($)	Property Tax Revenue Share from Oil and Gas Industry (Percent)
1989	3,079,358	363,364	11.8
1990	3,126,858	456,521	14.6
1991	3,339,072	711,222	21.3
1992	3,728,324	999,191	26.8
1993	3,746,908	977,943	26.1
1994	4,414,226	1,408,138	31.9
1995	5,283,359	2,023,526	38.3
1996	6,263,075	2,524,019	40.3
1997	6,030,695	2,056,467	34.1
1998	7,773,789	3,117,289	40.1
1999	9,497,368	4,739,187	49.9
2000	9,948,011	4,483,334	45.1
2001	10,590,411	4,713,046	44.5
2002	15,108,726	8,776,827	58.1
2003	16,271,267	9,727,945	59.8
2004	13,076,191	6,195,536	47.4

Sources: CDOLA 2001b; Verheyden 2002; La Plata County 2004b, 2005

Table 3-170 compares the property tax rates (levies) for La Plata and Archuleta Counties and other tax jurisdictions with statewide averages. The tax rate La Plata County is below the statewide county average because of several factors, including the substantial revenues from both tourism sales taxes and property taxes on producing gas properties, depending on the jurisdiction. The 2004 property tax rate in Archuleta County is slightly higher than the average for counties in Colorado.

The property tax levies in La Plata County are lower than the tax rates for most other Colorado counties. These property tax rates are lower in part because of the taxes contributed by the existing oil and gas development. The property tax revenues paid by the existing oil and gas facilities in La Plata County have offset the amount of property taxes required from individual taxpayers or other sources. Therefore, individual property owners in La Plata County have paid lower property taxes because of the increased taxes paid by the oil and gas industry.

Table 3-171 shows the estimated property taxes paid in 2001 to La Plata County and the local school district for both residential and commercial properties. This estimate was based on the tax rate for Durango School District 9R, where much of the proposed CBM development would occur. In 2001, the average market value for a typical single-family residential property was $193,000, and the average market value for a commercial property was $500,000 (La Plata County Energy Council 2002). Each single-family residence in the county would have paid an additional $578 and each commercial property owner an additional $3,947 (on average) in property taxes in 2001 to generate a comparable amount of revenue,

without the taxes paid by oil and gas (La Plata County Energy Council 2002). Owners of other types of properties in the county also paid lower annual taxes because of the revenues paid by the oil and gas industry.

Table 3-170 Comparative Property Tax Levies, 1990, 2000, and 2004

	Total Levy in Millions of Dollars		
Entity	1990	2000	2004
La Plata County	8.574	8.500	8.500
Archuleta County	16.561	17.257	19.750
Statewide Average for Counties	19.291	18.499	18.867
City of Durango	2.618	2.507	2.507
Town of Bayfield	7.920	5.964	5.950
Town of Ignacio	4.816	3.370	3.337
Statewide Average for Municipalities	8.343	7.729	7.643
Durango School District	39.710	21.052	16.617
Bayfield School District	44.551	39.326	22.764
Ignacio School District	38.300	15.958	4.183
Statewide Average for School Districts	44.519	41.865	39.498

Sources: BBC 2001a; CDOLA 2004; La Plata County 2005

Table 3-171 Impact of Oil and Gas Development and Production on Taxes Paid by Other La Plata County Taxpayers, 2001

	Single Family Residential at $193,000		Commercial Building at $500,000	
	SD 9R – Operating	La Plata County	SD 9R – Operating	La Plata County
2001 Taxes without Oil & Gas	$557	$415	$3,631	$3,203
2001 Taxes with Oil & Gas	$214	$160	$1,654	$1,233
Tax Savings due to Oil & Gas	$343	$255	$1,977	$1,970
Combined Annual Savings	$598		$3,947	

Source: La Plata County Energy Council 2002

In addition to the taxes paid directly to La Plata County, the oil and gas industry has also paid significant revenues to the local school districts. Table 3-172 shows the taxes paid by the oil and gas industry from 1997 to 2004 by school district. The oil and gas industry has paid over $80 million to the school districts in the Project Area since 1997 (Nuss 2003, Verheyden 2005).

Table 3-173 shows the total revenues for La Plata County, compared with the property tax revenues from oil and gas from 1989 to 2004. Property taxes from the existing oil and gas development have increased total county revenues in La Plata County. However, additional expenditures have been required as a result of oil and gas development, such as for increased for road maintenance. Figure 3–73 compares the total county revenues and total operating expenditures from 1985 to 2004 with the property tax revenues from oil and gas from 1989 to 2004. Both revenues and expenditures have increased since 1985. In addition, revenues from oil and gas property taxes have increased since 1989.

Table 3-172 Oil and Gas Tax Revenues to School Districts in La Plata County

School District	1997	1998	1999	2000	2001	2002	2003	2004
Durango								
Assessed Value (Million Dollars)	258.1	403.2	419.7	442.0	787.1	840.3	526.6	898.9
Mill Levy	27.633	22.378	21.5	21.052	15.394	17.307	21.553	16.617
Tax Collected (Million Dollars)	7.1	9.0	9.0	9.3	12.1	14.5	11.3	14.9
Bayfield								
Assessed Value (Million Dollars)	43.8	54.9	43.10	39.9	84.1	108.7	62.0	149.2
Mill Levy	39.942	37.582	38.766	39.326	28.847	18.008	28.100	22.764
Taxes Collected (Million Dollars)	1.7	2.1	1.7	1. 6	2.4	2.0	1.7	3.3
Ignacio								
Assessed Value (Million Dollars)	66.6	98.3	67.0	75.1	164.2	197.0	142.4	271.6
Mill Levy	22.163	17.429	17.471	15.958	8.825	7.598	7.598	4.183
Taxes Collected (Million Dollars)	1.5	1.7	1.2	1.2	1.4	1.5	1.0	1.1
Total to Schools (Million Dollars)	10.3	12.8	11.9	12.1	15.9	18.0	14.0	19.3

Sources: Nuss 2003, Verheyden 2005

From 1989 to 2004, revenues from oil and gas property tax ranged from 2 to 22 percent of total county revenues. Table 3-173 also shows the total county revenues with and without property taxes from oil and gas. As shown in this table, total county revenues would have increased from 1989 to 2004 with or without property tax revenues from gas production.

Total revenues in Archuleta County generally increased from 1993 to 2004. To date, taxes from gas production are a minor share of total county revenues. In 2004, approximately 29 gas wells were producing in Archuleta County (COGCC 2005). Therefore, the oil and gas industry contributes a smaller portion of the tax revenues in Archuleta County, compared with La Plata County. Total revenues would have increased in Archuleta County with or without property tax revenues from the existing CBM production. Table 3–174 shows the total county revenues and total operating expenditures for Archuleta County from 1993 to 2004.

3.15.2.4.3 Revenues to the State and Severance Tax Distributions

The State of Colorado levies a severance tax against proceeds from the sale of various minerals produced in the state. Redistribution of severance taxes, administered by the Colorado Department of Local Affairs, is another important source of county revenue. State severance taxes are assessed at between 2 and 5 percent of gross income from gas production. A rate of 5 percent is currently used in La Plata County. However, revenues generally accrue only when production increases because producers are allowed to credit property tax payments against the severance tax. Severance taxes are offset by credits, and no revenues are collected during periods of declining production.

Table 3-173 La Plata County Total Revenues, 1989 - 2004, Compared with Tax Revenues from the Oil and Gas, 1989 – 2004

Year	Total County Revenue ($)	Property Tax Revenue from Oil and Gas Industry ($)	Revenue Share from Oil and Gas (Percent of Total Revenue)	Revenue Without Property Tax Revenues from Oil and Gas ($)
1989	15,879,179	363,364	2.3	15,515,815
1990	17,035,896	456,521	2.7	16,579,375
1991	16,699,922	711,222	4.3	15,988,700
1992	18,423,453	999,191	5.4	17,424,262
1993	19,343,957	977,943	5.1	18,366,014
1994	22,120,020	1,408,138	6.47	20,711,882
1995	23,042,472	2,023,526	8.8	21,018,946
1996	26,843,662	2,524,019	9.4	24,319,643
1997	25,768,076	2,056,467	8.0	23,711,609
1998	27,837,503	3,117,289	11.2	24,720,214
1999	32,621,737	4,739,187	14.5	27,882,550
2000	37,369,125	4,483,334	12.0	32,885,791
2001	37,340,851	4,713,046	12.6	32,627,805
2002	44,459,051	8,776,827	19.7	35,682,224
2003	44,704,174	9,727,945	21.8	34,976,229
2004	43,317,946	6,195,536	14.3	37,122,410

Sources: CDOLA 2003b, La Plata County 2004b, 2005; Verheyden 2005

Table 3–174 Revenues and Expenditures in Archuleta County

Year	Total County Revenues ($)	Total Operating Expenditures ($)
1993	5,438,727	4,317,919
1994	5,825,447	4,560,995
1995	6,572,860	5,052,981
1996	7,067,284	5,145,638
1997	7,270,450	5,508,322
1998	8,105,384	6,074,746
1999	8,971,438	6,695,293
2000	10,638,866	7,438,245
2001	11,445,852	8,374,449
2002	12,900,000*	12,100,000*
2003	6,023,077	6,446,004
2004	6,609,072	6,679,625

* Rounded values

Sources: CDOLA 2003b, 2005g; Archuleta County 2005; Burchett 2005

Revenues from severance taxes that that can be attributed to the oil and gas industry in Colorado have fluctuated widely from 1993 to 2004, bottoming out in 1995. Since then, the severance taxes from oil and gas, measured both in terms of total attributable and as a share of total collections, have increased dramatically. For the period 1993 to 2004, Table 3–175 shows the total net severance tax revenues to the state from oil and gas production and the share of total severance tax revenues from oil and gas.

Table 3–175 Colorado Severance Tax Collections

Year	Severance Tax from Oil & Gas ($)	Share of Total Mineral Severance Tax from Oil and Gas (percent)
1993	13,469,344	60.6
1994	6,479,541	42.7
1995	1,632,524	15.1
1996	7,555,496	50.9
1997	18,688,357	61.7
1998	19,756,058	66.4
1999	23,326,711	68.7
2000	24,640,683	77.1
2001	54,383,726	87.8
2002	48,914,233	85.6
2003	23,612,982	73.0
2004	107,145,432	92.5

Sources: Colby 2001; Colorado Department of Revenue 2005

Half of the total revenues collected from the state severance tax go to the State Trust Fund and half go to the Local Impact Fund. Monies in the State Trust Fund are divided equally between loans to the Colorado Water Conservation Board and support for the Colorado Department of Natural Resources. Monies in the Local Impact Fund are divided between Energy and Mineral Impact Assistance Grants (85 percent) and Direct Distributions to Local Governments (15 percent).

Counties and municipalities receive direct redistributions of severance tax revenues from the Department of Local Affairs based on the number of employees involved in oil and gas production and who reside in the local jurisdiction. As shown in Table 3–176, direct distributions of severance tax revenues to La Plata and Archuleta Counties and other jurisdictions in the Project Area have fluctuated greatly, but have increased overall since 1993. In 2004, La Plata County received $451,750 in severance tax distributions (Colby 2005).

3.15.2.4.4 Energy and Mineral Impact Assistance Fund Grants

Both La Plata and Archuleta Counties also received revenues from grants available from the Colorado Energy and Mineral Impact Assistance Fund. These grants assist communities affected by the fluctuations in the energy and mineral industries in the state. Funds come from the state severance tax on energy and mineral production and from a portion of the state's share of rentals and royalties paid to the federal government. These funds are paid for leasing and production on land with federally owned minerals.

Table 3–176 Severance Tax Direct Distributions to La Plata and Archuleta Counties and Other Jurisdictions

	La Plata County				Archuleta County	
Year	La Plata ($)	Bayfield ($)	Durango ($)	Ignacio ($)	Archuleta ($)	Pagosa Springs ($)
1993	43,335	10,834	14,773	10,833	0	0
1994	20,191	6,424	7,989	6,424	0	0
1995	35,167	9,608	16,133	1,373	0	0
1996	30,772	10,919	16,527	7,871	665	0
1997	56,081	45,237	57,072	31,234	2,800	2,800
1998	25,654	39,678	67,946	39,303	3,930	0
1999	135,847	32,258	39,873	12,130	7,581	0
2000	145,558	50,342	43,932	21,111	9,744	3,533
2001	285,822	90,224	126,909	57,025	6,003	3,286
2002	205,077	22,923	34,359	12,836	2,031	0
2003	60,837	11,666	23,653	4,979	0	0
2004	205,068	47,552	50,524	8,916	0	0
2005	451,750	109,075	99,120	49,580	4,958	4,958

Sources: Colby 2001, 2005

Between 1993 and 2005, La Plata County received $31.3 million in grant awards. The grants distributed to the county were used to address impacts of oil and gas development, including improvements of roads and bridges, school districts, fire protection districts, and other governmental entities (La Plata County Energy Council 2002). During this same period, Archuleta County received $3.8 million in grants. The grant funds distributed to La Plata and Archuleta Counties each year from 1993 to 2005 are listed in Table 3–177.

Other entities that are eligible to receive these grants and loans include municipalities, school districts, special districts, and other political subdivisions and state agencies. A sampling of the types of projects funded includes water and sewer improvements, road improvements, recreation centers, senior centers and other public facilities, and fire protection buildings and equipment. They also may be applied to local-government planning. Because these funds are distributed based on the applications received, annual amounts are not as directly related to production, as is the direct distribution of severance taxes. Although these grants can provide a significant source of revenue, the annual amount may fluctuate significantly from year to year.

3.15.2.4.5 Distributions of Federal Mineral Royalties to Counties

La Plata and Archuleta Counties receive revenues from redistribution of mineral rents and royalties from federal land in Colorado. The total distributions to La Plata and Archuleta Counties from 1995 to 2004 are shown on Table 3–178 for federal mineral leases and royalties in Colorado. The portion of these total revenues that is attributable to natural gas royalties is also shown on the table.

Table 3–177 Energy Impact Assistance Grants to La Plata and Archuleta Counties

Fiscal Year	La Plata County[1, 2] ($)	Archuleta County[1, 2] ($)
1993	1,757,089	595,759
1994	638,629	205,158
1995	1,279,268	54,268
1996	704,017	74,043
1997	553,238	133,238
1998	758,714	13,714
1999	1,901,334	80,155
2000	3,456,557	594,559
2001	2,598,892	17,820
2002	3,072,999	274,115
2003	4,474,633	90,200
2004	4,385,931	588,106
2005	5,699,326	1,081,987
Total	31,280,627	3,803,122

Notes:
[1] Many grants are awarded to multi-county entities.
[2] County totals are calculated using an apportionment mechanism.
Source: Colby 2005

Table 3–178 Federal Rent and Royalty Distributions to Colorado and Project Area Counties

Year	Colorado ($)	Percent Gas Royalty	La Plata County ($)	Percent Gas Royalty	Archuleta County ($)	Percent Gas Royalty
1995	31,778,501	14	631,775	53	31,958	6
1996	32,394,356	15	571,162	76	33,007	4
1997	43,982,442	25	60,787	78	48,882	5
1998	41,171,387	20	789,358	87	48,397	30
1999	38,482,810	19	875,577	80	47,139	10
2000	47,573,602	24	1,285,007	78	67,236	64
2001	64,584,338	34	2,466,850	NA	633,587	NA
2002	41,568,853	24	1,120,035	86	53,139	91
2003	63,071,667	39	2,825,434	83	105,556	82
2004	89,860,209	45	3,482,074	87	82,120	92

Source: BBC 2001a; Minerals Management Service 2005; Colby 2005

The Minerals Management Service of the U.S. Department of the Interior disburses portions of lease fees, bonuses, and royalties paid for production of minerals on land with federal mineral ownership. After administrative charges are deducted, 50 percent of revenue from mineral rents and royalties from federal land is returned to the state of origin. In Colorado, these funds are then redistributed among the county governments, the State School Fund, and the State Water Conservation Board. Portions of these funds are also returned to the State Department

of Local Affairs to fund the grants available from the Energy and Mineral Impact Assistance program, discussed above.

Total distributions to Colorado have increased slightly from 1995 to 2004 and the share attributable to natural gas royalties ranged from 14 to 43 percent. In contrast, 53 to 87 percent of the federal distributions to La Plata County are attributed to natural gas royalties. Although total federal distributions that originate from production in Archuleta County have increased during this same period, the share attributable to natural gas royalties has risen because of increases in CBM production.

3.15.2.4.6 Sales Tax Revenues

The county and municipal governments receive revenues from local sales taxes. The local sales tax rate is 2 percent in La Plata County and 4 percent in Archuleta County. As shown in Table 3–179, revenues from both retail sales and county property taxes increased from 1993 to 2004.

Table 3–179 Retail Sales and County Sales Tax Revenues in La Plata and Archuleta Counties

	La Plata County		Archuleta County	
Year	Retail Sales ($000s)	Sales Tax Revenue ($000s)	Retail Sales ($000s)	Sales Tax Revenue ($000s)[1]
1993	584,571	5,863	67,915	1,530
1994	640,133	6,556	76,274	1,839
1995	702,226	6,927	86,583	2,040
1996	758,798	7,156	102,147	2,270
1997	769,613	7,560	118,584	2,620
1998	831,822	7,931	139,989	2,950
1999	883,846	8,623	157,632	3,160
2000	929,099	9,011	169,966	2,310
2001	1,009,925	9,538	184,000	2,554
2002	1,034,864	9,675	178,395	2,599
2003	1,068,070	10,044	171,239	2,437
2004	1,256,855	10,100	185,893	2,549

Note:
1. Prior to 2001, Archuleta County figures estimated using the ratio of county and state sales tax rates.

Sources: BBC 2001a; Colorado Department of Revenue 2005

3.15.2.4.7 Expenditures and Fiscal Indicators

In addition to contributing additional revenues, the oil and gas industry has also imposed demands on local government services and facilities, some requiring additional county expenditures. For example, local oil and gas industry employees and their families require services from local governments, principally La Plata County, the municipalities of Durango and Bayfield, and the school districts in Durango, Ignacio, and Bayfield.

Road-maintenance expenditures increase because of land development to accommodate population growth. In addition, vehicular traffic from existing oil and gas development has caused wear and tear on the local roads, primarily in La Plata County.

Expenditures for capital improvements in La Plata County increased by 6 percent per year from 1990 to 1995, compared with population growth of 4 percent per year over the same period. From 1995 to 2000, expenditures for capital improvements increased by 16 percent per year, compared with population growth of 2 percent per year. Expenditures in La Plata County for the years 1990, 1995, 2000, and 2004 are summarized in Table 3–180.

Table 3–180 La Plata County Operating Expenditures, 1990, 1995, 2000, and 2004

Parameter	1990 ($)	1995 ($)	2000 ($)	2004 ($)
General Government	2,538,203	3,293,679	4,825,909	7,767,025
Public Safety	2,996,078	4,232,018	5,616,273	11,760,281
Public Works	1,675,640	2,756,246	5,000,812	6,665,760
Health & Welfare	3,066,742	3,166,854	4,153,871	5,801,949
Auxiliary Services	481,675	1,150,525	1,583,143	2,275,607
Community Programs	1,419,466	1,609,239	2,100,038	2,766,334
Subtotal for Operating Expenditures	12,177,804	16,208,561	23,280,046	52,595,250
Capital Improvements	3,402,702	4,618,250	9,863,624	12,682,882
Debt Service	782,081	822,011	1,397,741	775,412
Total Expenditures	16,362,587	21,648,822	34,541,411	66,316,705

Sources: CDOLA 2003b, 2005g; La Plata County 2005

"Public works" includes the county road and bridge programs. Expenditures for public works are required to maintain and improve the network of roads in La Plata County. The county road network consists of 600 miles of road. Table 3–180 show the county expenditures for public works from 1990 to 2004. In 1990, expenditures for public works were 14 percent of the total county operating expenditures. For the year 2004, expenditures for public works were 13 percent of the total operating expenditures of the county.

The La Plata County Comprehensive Traffic Study (Bechtolt Engineering 1999) identified $251 million in road improvements needed countywide by 2020, based on an analysis of the projected volume of traffic and existing safety concerns. The estimated costs by priority of need are summarized in Table 3–181.

Capital projects for roads and bridges are funded through the engineering and maintenance costs centers of the Road and Bridge Fund. The main categories of revenues and expenditures for road and bridge work in La Plata County for the years 1998 through 2004 are shown on Table 3–182.

Table 3–181 Estimated Costs for Needed Improvements to La Plata County Roads

Priority	Costs (in Millions of 1999 Dollars)
Improvements Needed by 2001	50.3
Improvements Needed by 2010	11.2
Improvements Needed by 2020	134.5
New Roads and Alignments Needed by 2020	55.0
Total	251.0

Source: Bechtolt Engineering 1999

Table 3–182 Sources and Uses of Road and Bridge Funds, 1998, 1999, 2000, and 2004

Funding Sources and Expenditures	1998 ($)	1999 ($)	2000 ($)	2004 ($)
Funding Source				
Property Taxes	3,904,981	3,084,371	2,490,469	1,750,845
Highway Users Tax	2,083,244	2,220,217	2,300,000	NA
Intergovernmental Revenues	5,277,538	800,916	2,145,000	6,027,200
Sales Taxes	1,300,000	3,400,000	4,000,000	NA
Other Sources	328,769	661,458	706,186	5,211,277
Total	8,144,532	10,166,962	11,641,655	12,989,322
Expenditures				
Personnel	1,879,617	2,004,229	2,291,554	3,281,825
Operations	3,918,642	3,463,763	2,720,483	3,202,935
Capital Projects	249,810	3,772,664	7,435,311	6,146,000
Total	6,048,069	9,240,656	12,447,348	12,630,760

Note: NA = Not Available
Sources: BBC 2001a; La Plata County 2005

From 1988 to 2004, property taxes provided 29 percent of road and bridge funds, on average. Capital projects represented 48 percent of expenditures, on average, for the same period. In addition, La Plata County received a $2 million grant in the year 2000 from the Colorado Energy and Mineral Impact Assistance Fund.

The Public Safety Division of the Sheriff's Office handles traffic enforcement in unincorporated La Plata County and responds to calls for law enforcement, traffic control, and emergencies. As shown on Table 3–180, the portion of total county expenditures spent on public safety increased from 1990 to 2004. Expenditures for public safety represented 19 percent of total operating expenditures in 2004. The share of total operating expenditures for public safety is down, however, from 26 percent in 1995.

The expenditures and sources of revenue for public safety from 1998 to 2004 for La Plata County are shown in Table 3–183. As shown in the table, most of the expenditures for public safety are allocated to personnel, primarily Sheriff's officers.

Table 3–183 Funding for Public Safety in the La Plata County Sheriff's Office

Expenditures and Revenues	1998 ($)	1999 ($)	2000 ($)	2004 ($)
Expenditures				
Total Expenditures	1,867,845	2,123,827	1,889,193	2,626,683
Personnel	1,322,186	1,514,928	1,239,013	1,716,859
Revenues				
Directly Generated by the Office	238,600	285,085	219,747	372,200
Balance Required from General Revenue	1,629,245	1,838,741	1,669,446	2,254,483

Sources: BBC 2001a; La Plata County 2005

There are few oil and gas wells in Archuleta County. They are on federal land, and the oil and gas operator is responsible for maintenance of these roads. In addition, few employees of the oil and gas industry live in Archuleta County. Therefore, expenditures in Archuleta County have not increased as a result of oil and gas development.

3.15.2.5 Social Values, Quality of Life, and Tourism

The quality of life associated with a geographic location and the reasons people live there are subjective measures based on a variety of values. Some residents regard the oil and gas facilities in the Project Area as incompatible with the natural environment and the visual landscape. Many other people support oil and gas development, however, because of the positive economic effects.

Residents who own mineral as well as surface rights in the Project Area may support CBM development on the property for the direct benefit to their income. In contrast, landowners with no mineral ownership may view CBM development negatively.

Supporters of oil and gas development in southwestern Colorado, including some residents of La Plata County, generally view the industry as providing economic benefits. These include royalty payments, relatively high-paying jobs, and revenues to local government paid by the industry that support increased public services and lower taxes.

At the same time, some residents are concerned about the effects of gas development on the quality of life. These concerns typically include perceived effects related to air quality, water quality, visual appeal, noise levels, public safety, and land-use conflicts with residential properties.

Some residents have expressed concerns about effects from traffic related to CBM, such as noise, safety, and damage to rural roads from heavy trucks. In addition, landowners are worried about the safety of living near industrial facilities and flammable or hazardous materials.

Some residents are concerned that CBM development may reduce the number of visitors to the area and affect the tourism industry. The quality of the natural en-

vironment, the visual landscape, and the recreational opportunities in the region attract many visitors. Tourism is a major employment sector in the region. To date, however, gas development has not noticeably affected tourism in La Plata County (BLM et al. 2002).

3.15.2.6 Property Values

Some residents have expressed concern that CBM development has reduced property values in the Project Area. In some cases, CBM wells near private homes have created land-use conflicts between the industry and landowners. Primarily, landowners who do not own the mineral rights for their properties are concerned. These concerns involve the need to negotiate surface-use agreements, the cost of reaching agreements with mineral producers, the perception that landowners risk uncompensated damage, and the perceived need to monitor industry compliance with regulatory requirements. In addition, the sights, sounds, and vehicular traffic of CBM development have affected some landowners.

Private landowners are interested in estimating nearby CBM wells' actual effects on the market value of residential properties. The assessed value assigned to the property for taxes is based on market value. The La Plata County Assessor does not routinely adjust property values based on the presence of a nearby CBM well.

3.15.3 Environmental Consequences

This section analyzes the proposed project's potential effects on social and economic values. We analyzed these effects for three geographical areas: La Plata County, Archuleta County, and the NSJB regional impact area. The NSJB region is defined as La Plata, Archuleta, and Montezuma Counties in Colorado and San Juan County in New Mexico.

IMPLAN is a computer-based system used to estimate economic impacts as part of the NEPA process. Table 3–184 summarizes the total economic impacts derived from the IMPLAN model for the proposed project for all the alternatives (Levy 2005). The impacts are presented on an annual basis for each of the three geographic-impact areas and for two separate periods during the life of the project: field development, and peak production. The period of field development for any of the alternatives was assumed to begin in 2006 and to last for 5 years. With the exception of the No Action Alternative (Alternative 5), the peak production year was projected to be 2015 for all the alternatives. The average production period for a CBM well was estimated to be 30 years for the IMPLAN model.

CBM development on each of the representative jurisdictions in the Project Area would contribute to the economic impacts described in Table 3–184. In La Plata County these impacts are generated by CBM development on private, BLM and National Forest jurisdictions in approximately the following proportions: private 65 percent; National Forest 30 percent; BLM 10 percent; and State 5 percent. In Archuleta County, total economic impacts described in Table 3–184 would be derived from mostly National Forest development (85-pecent) and much less so private and State mineral estate development.

Table 3–184 Summary of the Total Economic Impacts per Year during Field Development and Peak Production, by Alternative

	Output (million $2004)			Employment (no. of jobs)			Personal Income (million $)		
Alternative/Phase[1]	La Plata County	Archuleta County	Northern San Juan Region	La Plata County	Archuleta County	Northern San Juan Region	La Plata County	Archuleta County	Northern San Juan Region
Alternative 1[2]									
Field Dev.	51.3	44.7	168.2	350	275	1,435	29.8	26.6	90.3
Peak Prod.	107.5	112.5	232.6	460	455	1,120	47.4	45.5	103.2
Alternative 2									
Field Dev.	108.4	60.8	283.5	715	380	2,395	63.3	36.0	153.5
Peak Prod.	239.3	151.9	410.1	1,020	610	1,975	105.3	61.5	182.0
Alternative 5									
Field Dev.	33.2	5.7	63.7	210	35	535	19.5	3.4	34.4
Peak Prod.	76.7	13.3	92.7	325	55	445	33.8	5.4	41.2
Alternative 6									
Field Dev.	48.8	10.9	100.9	315	70	855	28.6	6.4	58.3
Peak Prod.	109.2	25.8	146.6	475	105	650	48.5	10.5	61.3
Alternative 7									
Field Dev.	50.2	27.4	129.3	335	170	1,085	29.2	16.2	69.4
Peak Prod.	109.2	68.3	182.3	475	275	1,985	48.5	27.6	81.7

Notes:
1 Field Dev. = Field Development, Peak Prod. = Peak Production for all alternatives (2015).
2 Alternative 1 estimates are based on the number of wells from the DEIS.
Source: Levy 2005

The results of the IMPLAN model are expressed in terms of effects on output, employment, and personal income. "Output" is defined as the total economic impacts and is the sum of direct and secondary (indirect and induced) economic impacts measured in 2004 dollars. "Direct economic effects" are defined as the value of goods and services sold by industry, including the value of gas production. "Indirect" effects were calculated by applying IMPLAN multipliers to the direct effects and include secondary economic effects on the service industry and retailers from project employee spending. "Employment" is defined as the total number of jobs, including direct industry employment and supporting jobs. "Personal income" includes the sum of income from project-employee salaries and other income measures defined in the IMPLAN model, such as income to some local residents from private mineral royalties (BBC 2002).

The number of jobs increased between 1990 and 2005 in both La Plata and Archuleta Counties. Even without additional CBM development, the number of jobs in both counties is projected to increase from 2000 to 2025 because of continued economic expansion. The projected employment shown in Table 3–185 was considered the benchmark (baseline) number of jobs before additional CBM development begins. The number of jobs in 1990 and 2000, and the projected number of jobs in 2010 and 2025, are shown in Table 3–185 for both La Plata and Archuleta Counties.

Table 3–185 Employment Trends and Projections to 2025, La Plata and Archuleta Counties

County	1990	2000	2010	2025
La Plata County	19,191	30,811	40,993	53,803
Archuleta County	2,724	5,222	7,097	9,283

Source: BBC 2002

The differences among the benchmark number of jobs, the projected population, and the peak project-related employment were used to analyze the potential effects on population, employment, earnings and income, housing, and county facilities, services, and infrastructure. For the year 2010, the projected total number of new jobs (Table 3–185) and the projected total population in both counties (Table 3-150) are summarized in Table 3–186. We compared these projected numbers with the estimated employment at peak production for each alternative, as shown in Table 3–186. As shown in the table, "employment" includes jobs directly attributable to the CBM industry and jobs generated indirectly.

Table 3–186 Number of Jobs and Portions of Total Projected Employment and Population in 2010 for La Plata and Archuleta Counties, by Alternative

Alternative	Total Number of New Jobs[1]	Number of Jobs as a Portion of Total Employment[2] (percent)	Number of Jobs as a Portion of Total Population[3] (percent)
1	915	1.9	1.3
2	1,630	3.4	2.3
5	380	0.8	0.5
6	575	1.2	0.8
7	750	1.6	1.0

Notes:
1. The number of new jobs includes new jobs (direct and indirect) for the two counties
2. Projected total employment for La Plata and Archuleta Counties in 2010 is 48,090 (from Table 3–185).
3. Projected total population for La Plata and Archuleta Counties in 2010 is 70,761 (from Table 3-150).

Under any alternative, effects would be minimal on the local population, employment, earnings and income, housing, or facilities, services and infrastructure in La Plata or Archuleta Counties or the NSJB region. Effects on employment and income would be small, relative to the total number of jobs and associated income. The gas industry would, however, generate 380 to 1,630 well-paying jobs in the area. Employment at peak production for each alternative is compared with the benchmark employment in the year 2010, as shown in Table 3–186 for La Plata and Archuleta Counties together. There would be positive effects on local fiscal conditions and county revenues for any of the alternatives. These topics are summarized in the following subsections.

3.15.3.1 Population

Under any of the alternatives, CBM development would contribute a small number of new residents, compared with the general population of La Plata and Archuleta Counties. The population in the Project Area has grown significantly over the past decade, and this growth is expected to continue, with or without additional CBM development.

3.15.3.1.1 Alternative 1 — Proposed Action

Alternative 1 would result in a small influx of new employees who would migrate to the region. The total number of new employees required during peak production would represent a small increase in population, compared with the projected total population in the region. As shown in Table 3–186, the peak employment for this alternative would represent a 1 percent increase in population, compared with the total population of both La Plata and Archuleta Counties. As with other impact indictors, the change in employment cannot be attributed in an exact quantitative manner to CBM development on any one jurisdiction. Rather CBM development on National Forest, BLM and Private jurisdictions in La Plata County would contribute to employment in approximately the following proportions: private 65 percent; National Forest 30 percent; BLM 10 percent; and State 5 percent. In Archuleta County, employment and population impacts would be derived from mostly National Forest development (85 percent) and much less so private and State mineral estate development. Over the Project Area, CBM development on National Forest would contribute to about ⅔ of the new employment generated.

Most of the required number of employees for this alternative would already reside within daily commuting distance of the project. Many of the project employees would be expected to commute daily from Farmington, New Mexico, which is considered the regional center for the oil and gas industry (BLM et al. 2002). In addition, the number of employees in oil and gas extraction decreased between 1995 and 2001 for La Plata County (Table 3-158). Therefore, it is likely that many employees of the oil and gas industry would already live in the area and be available for work. Because few employees would be recruited from outside the region, only a small number of new residents would migrate into the region as a result of the project. Thus, there would be a small increase in population for this alternative and little or no effect on the demographics of the two counties or the NSJB region.

3.15.3.1.2 Alternative 2

With implementation of Alternative 2, there would be a small influx of new residents to the region because of project employment. The peak employment for this alternative would be larger, compared with the other alternatives. However, the peak employment for this alternative would represent a population increase of 2 percent, compared with the total population in both La Plata and Archuleta Counties. The majority of the project workers would come from the NSJB region, and a small number of workers would migrate into the region. Thus, effects on population and demographics would be similar to those of Alternative 1.

3.15.3.1.3 Alternative 5—No Action

Under implementation of Alternative 5, the total number of employees would be smaller than with the other alternatives. It is unlikely that an influx of new residents to the NSJB region would be associated with this alternative. Therefore, there would be little or no effects on population or demographics.

3.15.3.1.4 Alternative 6

The effects on population or demographics would be similar to those of Alternative 1.

3.15.3.1.5 Alternative 7

The effects on population or demographics would be similar to those of Alternative 1.

3.15.3.2 Employment

There would be a small increase in employment in the region under each of the alternatives. The new employment associated with each of the alternatives is shown in Table 3–184, and the employment at peak production is compared with the projected benchmark employment in Table 3–186. Employment over the life of the project would represent a small increase compared with the total employment in the region.

3.15.3.2.1 Alternative 1—Proposed Action

Under implementation of Alternative 1, there would be a small increase in employment, compared with the total projected employment in La Plata and Archuleta Counties. As shown in Table 3–186, the employment at peak production for this alternative would represent an increase of less than 2 percent, compared with the total employment in both counties. There would be a small increase in total employment in the two counties or the NSJB region for this alternative.

3.15.3.2.2 Alternative 2

As shown in Table 3–186, employment at peak production under Alternative 2 would be more extensive, compared with the other alternatives. The employment at peak production for this alternative would represent an increase of 3 percent, compared with the total employment in La Plata and Archuleta Counties. There would be a small increase in total employment in the two counties or the NSJB region for this alternative.

3.15.3.2.3 Alternative 5—No Action

Under Alternative 5, the total employment at peak production would be less compared with the other alternatives. However, the effects on total employment in the region would be similar to those for Alternative 1.

3.15.3.2.4 Alternative 6

The effects on total employment in the region would be similar to those for Alternative 1.

3.15.3.2.5 Alternative 7

The effects on total employment in the region would be similar to those for Alternative 1.

3.15.3.3 Earnings and Income

Implementation of any of the alternatives would have a small effect on earnings and income, compared with the total earnings and income in La Plata and Archuleta Counties. As shown in Table 3–186, employment at peak production generated by CBM development for any of the alternatives would represent a small percent of the total employment in the region. There would be little or no change in the earnings or per capita income in the region, because of the relatively small number of jobs created by CBM development, directly and indirectly, compared with total employment and income in the region.

3.15.3.3.1 Alternative 1—Proposed Action

Under Alternative 1, there would be a small increase in earnings or income in La Plata or Archuleta Counties and the NSJB region. As shown in Table 3–186, employment at peak production for this alternative would represent 2 percent of the total employment in the region. Jobs in the oil and gas industry are generally higher paying, however, relative to other employment sectors. For example, the existing jobs in the oil and gas sector represent less than 1 percent of the total employment in La Plata County, but these higher-paying jobs generate about 2.5 percent of the direct basic income of the county (CDOLA 2002b). In addition, most of the project-related income from employment would be spent in the NSJB region, of which 48 percent of the disposable income of the project-related employees would be spent in La Plata County (BBC 2002).

In addition to salaries, private mineral royalties from CBM production would be paid to some local residents who own minerals. This income would also be a component of personal income that would result from the proposed project. Local residents who own minerals would receive direct royalty payments from the companies: private royalties are paid at a rate of 12.5 percent of total production income. Both income from private royalties and secondary economic impacts from personal consumption spent locally are included as personal income in Table 3–184. Income from private royalties would be a small portion of the total personal income that would result from the proposed project (BBC 2002).

The number of jobs and the associated earnings and personal income from salaries would be small, compared with total employment and income in the region for this alternative. Therefore, there would be a small increase in earnings or average per capita income in the two counties or the NSJB region.

3.15.3.3.2 Alternative 2

Under Alternative 2, there would be more project-related employees, compared with the other alternatives. Therefore, additional earnings and personal income would be associated with salaries. The effects on earnings and per capita income in the region would, however, be similar to Alternative 1's effects.

3.15.3.3.3 Alternative 5—No Action

Under Alternative 5, there would be fewer project-related employees compared with the other alternatives. Therefore, there would be less earnings and personal income from salaries compared with the other alternatives. However, the effects on earnings and per capita income would be similar to those of Alternative 1.

3.15.3.3.4 Alternative 6

The effects on earnings and per capita income would be similar to those of Alternative 1.

3.15.3.3.5 Alternative 7

The effects on earnings and per capita income would be similar to those of Alternative 1.

3.15.3.4 Housing

There would be a small increase in the demand for local housing under any of the alternatives, and, therefore, a minor effect on the availability of housing. As shown in Table 3–186, the total number of CBM employees would represent a small increase in population compared with the total population or total available housing units in both La Plata and Archuleta Counties. In addition, most project-related workers are expected to be local residents who already live within commuting distance of the project. Therefore, the proposed project would result in a minor increase in demand for local housing in the region.

3.15.3.4.1 Alternative 1—Proposed Action

Implementation of Alternative 1 would result in a small increase in demand for local housing in both La Plata and Archuleta Counties. Employment at peak production for Alternative 1 would require 915 workers. Most of these employees already reside within commuting distance of the project, and, therefore, would not affect demand for housing. As shown in Table 3-162 and Table 3-163, more than 7,800 vacant housing units were available in both counties in 2004. In addition, projections by the county planning departments indicate that additional housing would be available by the peak in production of the proposed project (year 2015). Thus, there would be a small increase in demand on the local housing market and little or no effect on the availability of housing in the two counties or the NSJB region.

3.15.3.4.2 Alternative 2

Under Alternative 2, employment at peak production would be larger compared with the other alternatives; however, the effects on the local housing market or availability of housing would be similar to those of Alternative 1.

3.15.3.4.3 Alternative 5—No Action

The total employment required would be smaller compared with the other alternatives. However, the effects on the local housing market or availability of housing would be similar to those of Alternative 1.

3.15.3.4.4 Alternative 6

The effects on the local housing market or availability of housing would be similar to those of Alternative 1.

3.15.3.4.5 Alternative 7

The effects on the local housing market or availability of housing would be similar to those of Alternative 1.

3.15.3.5 County Facilities, Services, and Infrastructure

"County facilities, services, and infrastructure" are defined as law enforcement, education (schools), fire and emergency response services, hospitals, and utilities. There would be a small influx of new residents for the proposed project. Therefore, the proposed project would result in a small increase in demand for county facilities, services, or infrastructure. The potential effects of the additional project-related vehicular traffic associated with CBM development, including wear and tear on county and local roads and bridges, are analyzed in the section on Transportation.

3.15.3.5.1 Alternative 1—Proposed Action

Under Alternative 1, a small influx of new residents would be associated with the proposed project. The majority of project-related employees would be current residents of the NSJB region. Therefore, the proposed project would have a small effect on law enforcement, schools, fire and emergency response services, and hospitals. Some additional county services would be required during construction, such as responses from fire or emergency personnel or review by planning staff of permit applications. Because few new residents would migrate into the region because of the project, however, there would be a small increase in demand for county facilities, services, or infrastructure.

The project would not involve utility and service requirements that directly affect capacity. The companies would purchase needed utilities (electric power or water) from existing sources, and the service provider would supply the capacity needed. No other utilities would be affected.

The financial benefits to the counties from the proposed project would greatly outweigh the costs of any additional county services that may be required. Additional CBM development would result in significant increases in property tax revenues, compared with current revenues for both counties. In addition, grants from the Colorado Energy and Mineral Impact Assistance Fund would be available to address impacts that would result from CBM development.

3.15.3.5.2 Alternative 2

Under Alternative 2, the total peak employment would represent an increase of 2 percent compared with the total population in both La Plata and Archuleta Counties, and would be larger compared with the other alternatives. However, the majority of project-related employees would be current residents of the NSJB region. Thus, there would be few additional residents because of the project and a small related increase in demand for county facilities, services, or infrastructure.

3.15.3.5.3 Alternative 5—No Action

Under Alternative 5, the total employment and influx of new residents would be smaller compared with the other alternatives. However, the effects on county facilities, services, or infrastructure for this alternative would be similar to those of Alternative 1.

3.15.3.5.4 Alternative 6

The effects on the total employment and influx of new residents would be similar to those of Alternative 1.

3.15.3.5.5 Alternative 7

The effects on the total employment and influx of new residents would be similar to those of Alternative 1.

3.15.3.6 Fiscal Conditions of Local Government

The impacts on the fiscal conditions of both La Plata and Archuleta Counties are discussed in this section. The proposed project would result in additional revenues to both counties from a variety of sources. The primary sources of revenue from the proposed project include the *ad valorem* property tax, redistribution of severance taxes collected on gas production, grants from the Colorado Energy and Mineral Impact Assistance Fund, distributions of federal mineral royalties, and collection of sales taxes derived from project-related purchasing in the counties. The following sections summarize the primary sources of revenues for both counties that would be generated by the proposed project.

3.15.3.6.1 Alternative 1—Proposed Action

Under Alternative 1, both La Plata and Archuleta Counties would receive additional revenues from a variety of sources. Figure 3–74 shows the estimated average annual revenues to La Plata and Archuleta Counties from *ad valorem* property tax, severance tax, and both federal and state mineral royalties.

Assessed Valuation

Construction and operation of an additional 284 CBM wells in La Plata and Archuleta Counties would increase the total assessed valuation (tax base) by $69 million per year in current dollars. This rise in valuation would represent an increase of 3 percent compared with the tax base of both counties for the year 2004. The assessed value of oil and gas properties in La Plata County has consistently exceeded 30 percent of the total assessed valuation in recent years. The assessed value of CBM gas production and field equipment would continue to be a significant portion of the total assessed valuation in both counties over the life of the project.

As production declined, the assessed value of gas properties would account for a declining share of the total tax base over the life of the project. There is a direct correlation between the level of gas production and assessed valuation for CBM wells. Therefore, assuming a constant price for natural gas, gas production and assessed valuation would peak during the first years of the project and then begin to decline. In reality, natural gas prices are not constant. Therefore, changes in gas prices may either exaggerate or minimize the effects on the tax base during declining production in the later years of the project.

The total assessed valuation for both counties would increase because of the growing numbers of residential and commercial properties, with or without additional CBM development. The residential and commercial valuation is likely to increase as a result of the projected population growth during the life of the project. In La Plata County, the assessed valuation is estimated to increase at an av-

erage rate of 2.5 percent per year (Hammer, Siler, George Associates 1997). The gas industry's share of the tax base would decline to a small percent of the total assessed valuation in La Plata County in the later years of the project.

Ad Valorem Property Taxes

Under Alternative 1, *ad valorem* property taxes on production would generate additional revenues for both La Plata and Archuleta Counties. The property taxes on Alternative 1 production would generate a combined total of $48.1 million of revenue for both counties over the life of the project.

Alternative 1 would result in a projected total of $33.1 million in property tax paid to La Plata County. The total *ad valorem* property taxes paid to La Plata County under Alternative 1 over the life of the project for each of the alternatives are shown on Figure 3–75. These tax revenues would be generated from new private wells operating in La Plata County

Implementation of Alternative 1 would result in an average of $1.3 million in annual property taxes paid to La Plata County for the 30-year life of the project. The annual *ad valorem* property taxes that would be paid to La Plata County over the life of the project for each alternative are shown on Figure 3–74 and Figure 3–76.

Under Alternative 1, a total of $15.0 million in property tax would be paid to Archuleta County. Figure 3–77 shows the total *ad valorem* property taxes that would be paid to Archuleta County for each of the alternatives over the life of the project.

Alternative 1 would result in an average of $600,000 in annual property taxes paid to Archuleta County over the 30-year life of the project. The annual *ad valorem* property taxes paid to Archuleta County under each of the alternatives over the 30-year life of the project are shown on Figure 3–74 and Figure 3–78.

County revenues from gas production would decline in the later years of the project. Property tax revenues from production would, therefore, account for a declining share of the total county revenues over the life of the project for both La Plata and Archuleta Counties. Property tax revenues from gas production were $6.2 million, and total county revenues were $43.3 million for La Plata County in the year 2004. For Alternative 1, the county revenues from gas production would peak during the fifth or sixth year of production and then begin to decline as production waned, assuming a constant price for natural gas. In year 2015, property tax revenues from production would generate more than $1.3 million per year for La Plata County. Over the long term, annual property tax revenues from production would decline to about $300,000 in the later years of the project.

Assuming the 2004 total county revenues per year remain constant at $43.3 million (the year 2000 level) over the next 30 years, taxes from gas production would represent 3 percent of the total county revenues in the early years of the project and a smaller portion during the later years. In reality, total county revenues would increase with population growth, and taxes on production are likely to represent less than 1 percent of the total county revenues at the end of the project.

Revenues to the State Severance Tax Distributions

Under Alternative 1, the State of Colorado would receive $3.8 million in average annual royalties from state mineral leases, as shown on Figure 3–74. In addition, the State of Colorado levies a severance tax against the proceeds of the sale of various minerals produced in the state.

Revenue from the severance tax is divided evenly between the State Severance Tax Trust Fund and the Local Government Severance Tax Fund. The state fund is used to pay for a variety of natural-resource-related conservation programs throughout Colorado. The local-government fund, which is administered by the Colorado Department of Local Affairs, is used to provide grants and loans to cities and counties where mineral extraction occurs, to help pay for a variety of local facilities, services, and infrastructure. Thus, the proposed project would benefit residents of Colorado as a whole, and residents of counties in the Project Area in particular, through payment of severance taxes into these funds.

Redistribution of severance taxes, administered by the Colorado Department of Local Affairs, would be another source of county revenue. Revenues from severance taxes would be redistributed to the counties and municipalities affected by CBM development. Because of Alternative 1, the counties and municipalities in the Project Area would likely receive direct redistributions of severance taxes at an estimated average of $340,000 per year.

Energy and Mineral Impact Assistance Fund Grants

The county governments (and other entities) may apply for grants from the Energy and Mineral Impact Assistance Fund. These grants are awarded to assist communities affected by fluctuations in the energy and mineral industries in the state. Funds come from the state severance tax on energy and mineral production. They also are derived from a portion of the state's share of rentals and royalties paid to the federal government for leasing and production of minerals and mineral fuels on land with federally owned minerals. The counties and municipalities in the Project Area would be able to use these grants for various types of projects, such as improvements to water, sewer, and roads, recreation centers, senior centers and other public facilities, and fire protection buildings and equipment.

It is not possible to calculate a specific benefit that would be derived from grants in the Project Area because of the proposed project, because the amount of the annual grant is not directly related to production. The amount of the grant would likely fluctuate from year to year.

Federal Mineral Royalty Distributions to Counties

Under Alternative 1, the new federal wells in the project would generate substantial mineral-lease royalties for a variety of local, state, and federal government entities. As shown on Figure 3–74, preliminary estimates indicate that the proposed project would generate an annual average of $6.9 million in federal mineral royalties. Half of this revenue would be paid to the federal government. The other half would be paid to the State of Colorado and would be distributed according to a complex formula to various state and local governments.

The entities that would receive revenues would include La Plata and Archuleta Counties, individual municipalities in the counties, the State School Fund, the Colorado Department of Local Affairs, and the Colorado Water Conservation Board. In each county, federal mineral royalty payments would be divided among the county governments, local school districts, and local municipalities. Portions of these funds are also returned to the State Department of Local Affairs to fund the Energy Impact Assistance Grants program discussed previously.

Sales Tax Revenues

Under Alternative 1, most of the project-related purchases would be made outside of the Project Area. The results of the IMPLAN analysis suggest that approximately 98 percent of project-related expenditures would occur outside La Plata and Archuleta Counties (BBC 2002). Therefore, project-related purchasing and spending would result in a small amount of revenue to the counties from sales taxes.

The project would result in additional indirect payment of sales taxes as a result of purchases by employees, who would spend their earnings on a wide variety of goods and services provided by businesses in local communities. However, minimal additional revenues from sales taxes would be collected in La Plata and Archuleta Counties because the majority of the CBM-related purchasing would occur outside of the Project Area.

3.15.3.6.2 Alternative 2

Alternative 2 would result in substantial increases in tax revenue and royalty collections from CBM development compared with the current county revenues, as summarized in Figure 3–79. The increases in assessed value, property tax revenues to both counties, severance tax paid to the state, federal mineral royalties, and sales tax would all be more than 50 percent larger than the levels associated with Alternative 1. *Ad valorem* property taxes would be the primary direct source of increased revenues for both La Plata and Archuleta Counties. Over the life of the project, the property taxes on production would generate a combined total of $93.8 million of additional revenue for both La Plata and Archuleta Counties.

Alternative 2 would result in a total of $73.5 million in *ad valorem* property tax that would be paid to La Plata County, as shown in Figure 3–75. The annual *ad valorem* property taxes would result in an average of $2.9 million paid to La Plata County over the 30-year life of the project (Figure 3–79).

The total *ad valorem* property taxes that would be paid to Archuleta County under Alternative 2 would be $20.3 million, as shown in Figure 3–78. The annual *ad valorem* property taxes paid to Archuleta County under Alternative 2 would result in an average of $800,000 over the 30-year life of the project (Figure 3–79).

Property tax revenues from production would account for a declining share of total revenues for both La Plata and Archuleta Counties over the life of the project. As shown in Figure 3–76 and Figure 3–78, annual property tax revenues from production would decline to about $500,000 in the later years of the project.

Assuming the total county revenues per year remain constant at the year 2004 revenue level over the next 30 years, revenues from gas production would represent a small percent of the total paid to the county in the later years of the project. In reality, total county revenues would increase with population growth, and taxes on production are likely to represent less than 2 percent of the total paid to the county at the end of the production period.

3.15.3.6.3 Alternative 5—No Action

Alternative 5 (No Action) would result in increased tax revenue and royalties collected from CBM development compared with current county revenues, as summarized on Figure 3–82. These revenues would, however, be considerably less than would be realized with the other alternatives. As shown in Figure 3–75 and Figure 3–78, the property taxes on production would generate a combined total of $25.1 million of additional revenue for both La Plata and Archuleta Counties.

The increases in assessed value, property tax revenue, severance taxes paid to the State of Colorado, federal mineral royalties, and sales taxes would all be 60 percent less than the levels associated with Alternative 1.

3.15.3.6.4 Alternative 6

The increases in assessed value, property tax revenue, severance taxes paid to the State of Colorado would be approximately equal to Alternative 1. Federal mineral royalties, and sales taxes would all 40 percent less than the levels associated with Alternative 1.

3.15.3.6.5 Alternative 7

The increases in assessed value, property tax revenue, severance taxes paid to the State of Colorado would be approximately equal to Alternative 1. Federal mineral royalties, and sales taxes would all 20 percent less than the levels associated with Alternative 1.

3.15.3.7 Impacts from Eventual Decline in Gas Revenues and Boom-and-Bust Cycle

The proposed project is unlikely to result in a significant economic boom-and-bust cycle. There would be a small reduction in employment at the end of the project, compared with the total employment in the region. The primary consideration for the analysis of boom-and-bust effects would be the eventual decline in production-related revenues in the later years of the project.

3.15.3.7.1 Alternative 1—Proposed Action

Implementation of Alternative 1 is unlikely to result in a significant boom-and-bust cycle in La Plata and Archuleta Counties. Employment and county revenues from production are analyzed to assess the potential for a boom-and-bust cycle. The project-related employment in the two counties in the Project Area would decline in the later years of the project. However, the total project-related employment would represent less than 2 percent of the direct basic employment in the region. In addition, the project-related employment and associated spending in the region would begin and end in a gradual manner over the 30-year production period.

There is a direct correlation for properties with CBM wells between the level of gas production and the amount of revenues paid to the counties. Gas production for this alternative would peak in the year 2015 and then decline gradually until the year 2041 or the end of the production period for the CBM wells. As production declined in the later years of the project, production-related revenues paid to both La Plata and Archuleta Counties would decline. The county revenues that are directly or indirectly related to production include property taxes, severance tax distributions and grants from the State of Colorado, and federal mineral royalties redistributed to the counties. *Ad valorem* property taxes on gas production would be the most significant revenues to the county governments.

The projected production curve for the new CBM wells under Alternative 1 was analyzed in the IMPLAN model (BBC 2002) and is shown in Figure 3–83. This curve is considered typical of the production pattern for any of the project alternatives and illustrates how production from the existing CBM wells declines over time. The IMPLAN model assumed that production for the new CBM wells would begin in 2006 and peak in the year 2015. Assuming that no new development would occur, production would decline gradually over time and eventually would end. Abandonment would occur in about 2041, assuming an average 30-year production period for the new wells.

County revenues from gas production would decline in the later years of the project in a manner similar to the production curve shown in Figure 3–83. We estimated the annual aggregate production values using projected production rates used in the IMPLAN model runs and applying a constant price of $2.06 per MCF, which was the 1999 gas price for the NSJB and is the projected average price through the year 2010 (BBC 2002, COGCC 2000b).

The reduction in production-related revenues during the later years of the project would have minor to moderately detrimental effects on the budgets of La Plata and Archuleta Counties. The effects of declining production on the local tax bases of La Plata and Archuleta Counties would be affected by future gas prices. Therefore, predicting the production-related revenues to the counties for the life of the project is highly speculative. However, using a constant 1999 price for gas, the oil and gas industry's share of La Plata County's property tax base is estimated to decline to a small percent of total county revenues during the later years of the production period.

Property taxes in the counties support the schools, county government, and services. Therefore, the budgets of the two counties would be affected as production-related tax revenues decline in the later years of the project. Additional revenues from CBM production would allow the counties to operate at a higher level of service than would be possible when revenues decline, unless the additional revenues were received from other sources. Alternative sources of revenue would be needed to support county services as production-related property tax revenues decline.

The population and employment in both La Plata and Archuleta Counties are projected to continue to grow, however, with or without CBM development. Construction of additional residential and commercial properties, to accommodate the projected growth in population, would increase the total assessed valuation for

both counties. In addition, property values are expected to continue to appreciate at a rate of 6.9 percent per year (BBC 2002). Thus, the total assessed valuation and property tax revenues would increase over the life of the project, even without production.

However, increases in population and growth in the number of residential and commercial properties would also increase expenditures for county services and infrastructure. Total county revenues in both counties have increased since 1993 and expected to continue to increase over the life of the project.

For this alternative, production-related revenues to the counties would begin and end gradually over the 30-year production period. The county governments would have some time to develop strategies for obtaining other sources of revenue, because the decline in production would be gradual. La Plata County has defined several strategies to minimize the impacts of reduced revenues as production declines. Because of the revenues contributed by the oil and gas industry, the La Plata County mill levy of 8.5 has been constant since 1992, one of the lowest in the state. It is possible that the county mill levy would be increased, to offset the loss of production-related revenues at the end of the project. The preferred strategy is to maintain property tax levies at or near current levels, rather than allow tax rates to decline as the total assessed valuation increases from additional CBM development (Hammer, Siler, George Associates 1997).

The portion of total county revenues derived from production-related revenues would decrease as the county tax base increases over time. In addition, total revenues for both counties increased from 1993 to 2004 and are expected to continue to grow over the life of the project. As revenues outpace expenditures, the counties may be able to direct funds toward future years, when tax collections from oil and gas are anticipated to decline. Long-term economic growth and diversification would likely somewhat offset the gradual decline in production-related revenues. It is probable that other sources of revenue would be available to the counties at the end of the project.

Overall, the proposed project would benefit total county revenues. The additional revenues that the counties would receive because of CBM development would greatly offset the adverse effects associated with the eventual decline in gas revenues.

3.15.3.7.2 Alternative 2

Under Alternative 2, the potential effects of the eventual decline in employment and county revenues in the later years of the project would be larger compared with the other alternatives. The effects on La Plata and Archuleta Counties related to a potential boom-and-bust cycle for this alternative would, however, be similar to those of Alternative 1.

3.15.3.7.3 Alternative 5—No Action

Production-related revenues would decline over time for this alternative as the production rates for the new CBM wells decrease. Additional sources for county revenues may be required at the end of the project.

3.15.3.7.4 Alternative 6

The effects on production-related revenues and employment would be similar to those of Alternative 1.

3.15.3.7.5 Alternative 7

The effects on production-related revenues and employment would be similar to those of Alternative 1.

3.15.3.8 County Expenditures

The proposed project would increase operating expenditures for both La Plata and Archuleta Counties. The additional revenues that the counties would receive because of additional CBM development, however, would greatly offset any increased expenditures that may be result from the project. Overall, the proposed project would benefit total county revenues.

3.15.3.8.1 Alternative 1—Proposed Action

Under Alternative 1, some operating expenditures for both La Plata and Archuleta Counties would increase as a result of the project. However, there would be little or no increase in county expenditures for the few new residents associated with the project. The majority of the project-related employees would be current residents of the NSJB region, and a small number of new residents would relocate to the area because of the project.

The proposed project would affect county expenditures for public works moderately, because of increased project-related traffic and transport of heavy equipment on local roads. The additional vehicular traffic associated with CBM development would increase wear and tear on some county and local roads and bridges, increasing maintenance costs to the counties. The effects of the project-related vehicular traffic, including wear and tear on county and local roads and bridges, are analyzed in the section on Transportation.

In addition to wear and tear on county roads, expenditures may increase for various county departments. For example, project-related traffic and construction may increase expenditures for public safety, such as law enforcement, traffic control, and emergency response. In addition, there would be an increased demand on some planning departments, such as for review of land-development-permit applications.

Overall, the proposed project would benefit total county revenues. The additional revenues the counties would receive because of CBM development would greatly offset the additional county expenditures that may be required.

3.15.3.8.2 Alternative 2

Under Alternative 2, the potential effects on county expenditures would be larger compared with the other alternatives. Overall, the effects on county expenditures would be greatly offset by additional revenues to the counties.

3.15.3.8.3 Alternative 5—No Action

Under this alternative, there would be a smaller effect on county expenditures compared with the other alternatives; the effects on county expenditures, however, would be similar to those of Alternative 1.

3.15.3.8.4 Alternative 6

The effects on county expenditures would be similar to those of Alternative 1.

3.15.3.8.5 Alternative 7

The effects on county expenditures would be similar to those of Alternative 1.

3.15.3.9 Social Values, Quality of Life, and Tourism

Additional CBM development in the Project Area may affect social values, or subjective measures of the quality of life, depending on the locations of CBM facilities. These values would be affected on a case-by-case basis, and would depend on the perceptions of the individuals who are near the CBM facilities. Tourism is unlikely to be affected, however, by additional CBM development.

CBM development would create additional traffic on local roads for any of the alternatives. Traffic congestion and an increased risk of accidents may exist at some locations where CBM-related vehicles and equipment would enter and exit major roads. Noise, dust, and road damage would be associated with increased traffic and construction operations. Most of the potential effects related to social values, visual resources, recreational experience, and quality of life are addressed in more detail in resource-specific sections of the DEIS; therefore, these effects are only summarized in this section.

The CBM-related activities and facilities would change the visual appearance of some landscape areas for any of the alternatives. Overall, CBM development is not a prominent visual feature (La Plata County 2002b). Visual effects for an individual facility, however, are based on the type of site, distance from a point of observation, topography, vegetation, and landscaping.

Visual effects, noise, and dust generated during drilling, operation, and maintenance of the proposed CBM wells would be an annoyance for nearby residents and would affect the character of open space in some areas of the counties. New access roads and an increased level of activity in areas that are currently secluded and isolated would create conditions that some local residents would perceive as negative. These changes would alter the recreational experience in primitive or roadless areas.

Additional CBM development in the Project Area is unlikely to affect tourism. Tourism is a major employment sector in the region and is expected be continue to be an important source of revenues and income, with or without CBM development. Based on the increase in tourism-related employment (retail trade and services) in La Plata County from 1990 to 2003 (Table 3-155), gas development has not noticeably altered tourism. CBM development would continue to have minimal impacts on tourist attractions in the local area or region.

3.15.3.10 Property Values

Concern has been raised that CBM development may affect some private residential property values in the Project Area. The potential to affect both properties with CBM wells on them and properties near CBM wells on other lots is considered in this section.

It is difficult to measure the effect of any one parameter on property values with statistical validity, because of the numerous variables that affect them. Generally, residential property values are affected by the location of the property; the amount of land; the age, condition, and size of the residence; the type and quality of construction; the presence and condition of other structures on the property; and many other, less tangible, factors such as views, access, and proximity (or lack of) to services. In addition, the value of a residential property also depends on the subjective opinion of potential buyers.

Likewise, many variables associated with CBM development could influence the potential to affect property values. These variables include the location of new CBM facilities relative to residences, the surface and mineral ownership of the land affected, the land uses at these locations, and other factors.

The proposed CBM facilities would be on land with various ownership and land uses. The value would be affected differently depending on mineral ownership where wells would be on private property. Private property with wells falls into two categories of mineral ownership: (1) property where the surface is privately owned along with the minerals (private surface ownership and private mineral ownership), and (2) split-estate property (private surface ownership and federal mineral ownership).

In the case of property with both private surface ownership and private mineral ownership, the landowner would choose whether to allow a CBM well on the property. In these cases, the landowner would receive royalty payments from gas production if a well were developed, and would likely perceive a CBM well on the property as having a positive effect on the property value. Conversely, surface owners with no mineral ownership (split estate) do not have a choice about situating a well on the property. Therefore, they could consider a well as having a negative impact on property value, because they could see and hear it but would derive no revenue from it. Only a limited number of CBM facilities are proposed on split-estate residential properties.

The specific locations of CBM facilities on split-estate properties would usually be negotiated with landowners through the surface-use-agreement process. In cases where a surface use agreement is not successfully negotiated, however, the operator can go forward with a proposed CBM well without landowner approval. Surface owners are generally compensated for the value of land displaced by CBM facilities, in the form of damage payments from the operators. Damage payments to landowners are likely to offset some of the perceived reduction in value of a property where a CBM well is located. Compensation paid to surface owners may not be considered adequate, however, to offset removal of land from other uses or effects on property value.

Surface owners of split-estate properties would probably negotiate to place wells in less visible locations as part of the surface-agreement process, reducing the potential for effects on property value. Decisions on where to locate these CBM facilities could, however, affect adjacent or nearby landowners. The potential effect on nearby landowners is independent of mineral or surface ownership and depends primarily on proximity and on mitigation of noise and visual effects.

Some of the new CBM wells that would be developed in the area would be drilled in known locations, and some would be developed somewhere within general locations or open-drilling "windows." These windows are 20 to 30 acres, some smaller and some larger, depending on the size and dimension of the specific section of land. Impacts on the value of a property would vary, based on the specific location of the CBM wells and associated facilities relative to nearby residences. Since the proposed locations for most of the new CBM wells are in drilling windows rather that at known sites, potential effects on residential property values would be estimated on a case-by-case basis when the well locations are known. In general, wells drilled farther away or obstructed from view would have less potential to affect residential properties than would those completed closer to residences.

Because of all of these factors, the potential impacts on individual property values that could result from CBM development would be highly variable and difficult to quantify. BBC prepared a report, "*Measuring the Impact of Coalbed Methane Wells on Property Values: A Working Paper*" (BBC 2001b), to assess potential impacts on residential property values from CBM development. This study indicated that some positive and some negative effects on property values have resulted from proximity to CBM wells that had already been developed in the area.

In the study, BBC attempted to compare sales of properties with CBM wells on or near them to sales of similar properties without CBM wells. BBC concluded that only a small number of the properties sold between 1989 and the first half of 2000 were affected by the proximity of a CBM well. Over this 11-year period, the number of properties sold with a CBM well at the time of sale was too small to analyze statistically. The BBC analysis concluded, however, that the value of these properties was affected negatively by the presence of a CBM well. In addition, properties sold in this period without wells, but near them on adjoining properties, showed effects on property value that were highly variable and both positive and negative.

As stated earlier, specific impacts on residential property values can be estimated only on a case-by-case basis, considering all the relevant variables that affect property values. Individual effects on property values must be considered when comparing properties with on-site or nearby wells with properties without them. BBC's study considered only some of the parameters that control the value of a residential property.

In Table 3–187, the parameters BBC used are compared with the factors used by the La Plata County Assessor's Office to establish a property value assessment. As shown in the table, not all the variables used by the assessor to set values for real estate were considered in the BBC model. In addition, other important fac-

tors that affect real estate value also were not considered in BBC's model. These factors include the "neighborhood" where a property is located, as well as topography, vegetation, water features, views, the quality of construction and finish, and the general condition.

Many of these factors cannot be modeled effectively to compare properties, because they are less tangible and more difficult to quantify. The same is true of the subjective opinion and preferences of the potential buyers for a property. The location-related factor included in the model was distance from Durango. Although distance provides good information regarding the properties that were included in the evaluation, it has no direct effect on value.

Table 3–187 Property Value Assessment Factors

Factor	La Plata County Assessor	BBC Model
Parcel Number	X[1]	
Date of Sale	X	X
Sale Price	X	X
Lot Size	X	X
Type of Use (vacant, residential, mobile home)	X	X
Distance from Durango (miles)		X
Year of Construction (age of house)	X	X
Square Footage by Floor Level	X	X
Total Improved Square Footage	X	
Garage (type & square feet)	X	X
Number of Bathrooms	X	
Number of Bedrooms	X	
Type of Heat	X	

Note:
1. X indicates that the factor is used (blank indicates factor is not used) for property value assessment.

Sources: Allen 2001; BBC 2001b

Given the limitations of the BBC study, it cannot be considered an accurate predictive model for assessing potential effects on property value from development of CBM wells.

The La Plata County Assessor does not routinely adjust assessed property values based on proximity of a CBM well. The assessor would consider an adjustment to the assessed value for CBM well effects, however, if it could be shown that the market price of a property was affected (Kotlar 2000). La Plata County has identified the need for a case-by-case analysis of properties before wells are constructed, to identify damages and compensation for the surface owner (La Plata County 2002b).

In general, property values in La Plata County have appreciated by 6.9 percent per year over the past decade and are expected to continue to appreciate at this rate (BBC 2001b). Some property values could be reduced by effects of well proximity but would be expected to increase in value afterwards at the same relative rate, as would properties with no effects from wells.

From another perspective, additional CBM development would increase the total annual revenues to both La Plata and Archuleta Counties. County revenues from *ad valorem* property taxes on gas production would increase from the proposed additional CBM development for the life of the project. Therefore, if the values of some properties were reduced, this would be unlikely to reduce the total property tax revenues to the two counties in the Project Area. Overall, additional CBM development would increase the property tax revenues for both counties in the Project Area, despite modest decreases in property values in some cases.

Although they are not directly related to property value, property tax revenues generated by CBM development would offset the amount of taxes that would otherwise have to be collected from other sources. For example, individual landowners could pay reduced amounts of annual taxes because of the increased property taxes paid by the proposed CBM production.

3.15.3.11 Environmental Justice

Under Executive Order 12898, in 1994, proposed projects under the jurisdiction of federal agencies must address "environmental justice" in minority and low-income populations. The analysis of project effects must include the potential for disproportionately high, adverse human health and environmental impacts on low-income and minority populations.

The proposed project would have no additional or disproportionate effects on minority populations. As shown in Table 3-153, there are smaller percentages of minorities in both La Plata and Archuleta Counties, compared with Colorado as a whole. The statewide population in the year 2000 was 4 percent black, compared with 0.1 percent in Archuleta County and 0.2 percent in La Plata County. In the year 2000, the statewide population was 17.1 percent Hispanic. For the year 2000, the Hispanic population in La Plata County was 10.4 percent and in Archuleta County, 16.8 percent. In the Project Area, the minority populations include a higher number of Native Americans, compared with the remainder of the state. For example, in 2000, Native Americans made up 5.8 percent of La Plata County, compared with 1 percent statewide.

Nor would the proposed project have additional or disproportionate effects on low-income populations. As shown in Table 3-161, both the median household income and the per capita income in La Plata and Archuleta Counties are slightly lower than the statewide figures. In the year 2000, nearly 50 percent of the households in both counties earned an annual income of less than $20,000. As shown in Table 3-160, the 1999 annual incomes for 8.9 percent of Colorado residents place them below the poverty line. The percentages for both counties are somewhat higher. In La Plata County, 10.4 percent of the residents were considered living below the poverty line in 1999. For Archuleta County, 12.7 percent of the residents were considered living below the poverty line. However, regional differences in cost of living may account for some of the differences in income. There would be no disproportionate effects on neighborhoods with low-income populations, because the proposed locations of the project facilities are geographically dispersed throughout the Project Area.

3.15.4 Cumulative Effects

To analyze cumulative effects on social and economic values, we estimated the potential effects of CBM development in the NSJB by calculating the sum of the socioeconomic effects of the following past, present, and reasonably foreseeable actions.

- The existing oil and gas development in the Project Area, as previously discussed in the section on Affected Environment.
- The Preferred Alternative of the Final Environmental Impact Statement for Oil and Gas Development on the Southern Ute Indian Reservation (BLM et al. 2002).
- The alternatives considered for the proposed project.

With or without additional CBM development, the populations of both counties in the Project Area are expected to increase over the life of the proposed project. Therefore, additional socioeconomic effects are likely to occur because of this anticipated community expansion. The current trends in development indicate that population, employment, housing, local facilities, services and infrastructure, and total county revenues would increase over the life of the project, with or without additional CBM development in both La Plata and Archuleta Counties.

3.15.4.1 Population

Under Alternative 1, the cumulative change in population that would result from employment in the oil and gas sector would represent an increase of less than 3 percent, compared with the total in the region. Therefore, there would be a small increase in population, and little or no effect on the demographics of La Plata and Archuleta Counties or the NSJB region.

However, the populations in both La Plata and Archuleta Counties are expected to continue to increase, with or without additional CBM development. Between 1990 and 1999, the population of unincorporated La Plata County increased by about 54 percent. The population in Archuleta County increased by more than 25 percent between 1993 and 1998 (BBC 2002). The population in the region is also projected to increase over the life of the project.

The cumulative effects on population and demographics for Alternative 5 would be the same as those of Alternative 1. Under Alternative 2, the cumulative employment would be larger, compared with the other alternatives. The cumulative employment would represent an increase in population of less than 4 percent, however, compared with the total population of both La Plata and Archuleta Counties. In addition, the majority of the project workers would come from the NSJB region. Therefore, the cumulative effects on the population and demographics for Alternative 2 would be similar to those of Alternative 1.

The cumulative effects on population and demographics for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.15.4.2 Employment

Under Alternative 1, the cumulative employment in the oil and gas sector would represent an increase of 3 percent, compared with the total employment in the region. In addition, the regional economy is well diversified. The cumulative employment in the oil and gas sector would represent a small increase in total employment in La Plata or Archuleta Counties or the NSJB region.

The cumulative effects on total employment in the region for Alternative 5 would be the same as those for Alternative 1. The cumulative employment in the oil and gas sector would be greater for Alternative 2 compared with the other alternatives. The cumulative employment for Alternative 2 would represent less than 4 percent of the total employment in the region. Therefore, there would be a small increase in the total employment in the two counties of the NSJB region and the cumulative effects would be similar to those of Alternative 1.

The cumulative effects on total employment in the region for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.15.4.3 Earnings and Income

Under Alternative 1, the cumulative number of jobs in the oil and gas sector would be small compared with total employment and income in the region. Therefore, there would be a small increase in earnings or per capita income in La Plata or Archuleta Counties or the region. The cumulative effects on earning and income for Alternatives 2, 5, 6, and 7 would be similar to those of Alternative 1.

3.15.4.4 Housing

For any of the alternatives, the cumulative number of new residents who would require housing would be small. Therefore, there would be a small increase in demand on the local housing market and little or no effect on the availability of housing in La Plata or Archuleta Counties or the NSJB region.

3.15.4.5 County Facilities, Services, and Infrastructure

For any of the alternatives, the cumulative employment for CBM development would result in a small number of new residents compared with the total population of the two counties. There would be a small increase in demand for county facilities, services, and infrastructure because there would be few additional residents as a result of the project. However, the populations in both La Plata and Archuleta Counties are projected to increase, even without additional CBM development. Therefore, there may be impacts on county facilities, services, or infrastructure from population increases that are unrelated to CBM development.

3.15.4.6 Fiscal Conditions of Local Government

The cumulative revenues associated with Alternative 1 would generate substantial additional revenues for both La Plata and Archuleta Counties. *Ad valorem* property taxes would be the primary direct source of increased revenues for both La Plata and Archuleta Counties. Cumulatively, Alternative 1 would increase annual property tax revenues to La Plata County by $1.3 million, compared with

current revenues. Cumulatively, Archuleta County annual property tax revenues would increase by $600,000, compared with current revenues.

The new CBM wells associated with Alternative 1 would generate little or no revenues for the SUIT. However, assuming a constant gas price ($2/mcf) over the life of the project, the cumulative CBM wells in the NSJB would generate an estimated total of $118 million (1997 dollars) in revenues to Colorado tribes over the life of the project (BLM et al. 2002). The cumulative royalties to the SUIT from CBM development on tribal land would generate an average of $5.9 million per year (1997 dollars and constant gas price) (BLM et al. 2002).

Cumulatively, Alternative 2 would increase annual property tax revenues to La Plata County by $2.9 million compared with the current level. Annual property tax revenues to Archuleta County would increase by $800,000 compared with the current level. The cumulative revenues to the SUIT would be the same as for Alternative 1.

The cumulative effect of Alternative 5, if additional federal wells are not allowed, would be a loss of additional revenues to both counties compared with the various action alternatives. Cumulatively, annual property tax revenues to La Plata County would increase by $0.9 million compared with current revenues. Annual property tax revenues in Archuleta County would increase by almost $70,000, compared with current revenues. The cumulative revenues to the SUIT would be the same as those of Alternative 1.

The cumulative effects on county revenues for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.15.4.7 Impacts from Eventual Decline in Gas Revenues and Boom-and-Bust Cycle

Under Alternative 1, the cumulative effects of oil and gas development would affect county revenues moderately at the end of the project. As of the year 2000, revenues for the existing oil and gas production in La Plata County were considered to be at an all-time high (La Plata County 2002a). As the production rates for the cumulative CBM wells in the La Plata County decrease, production-related revenues would decline over time, with or without additional CBM development. The total revenues for both counties are projected to increase over time, however, regardless of the decline in production-related revenues. Overall, county revenues from property taxes are expected to increase over time. It is likely that the reduced property tax revenues that would result from the end of the project would be somewhat offset by increased total assessed valuation in La Plata County, from additional residential and commercial development. Additional sources of revenue may be required, however.

The cumulative effects on county revenues and the potential for a boom-and-bust cycle for Alternatives 2, 5, 6, and 7 would be similar to those of Alternative 1.

3.15.4.8 County Expenditures

Under Alternative 1, the cumulative oil and gas development would have a moderate effect on county expenditures, but these costs would be greatly offset by the

additional county revenues from gas production. County expenditures are likely to increase with or without additional CBM development. The populations in both La Plata and Archuleta Counties have increased at a high rate over recent years and are projected to continue to grow. Therefore, there may be impacts on county expenditures because of general increases in population that are unrelated to CBM development.

Under Alternatives 2, 5, 6, and 7 the cumulative effects on county expenditures would be the same as those of Alternative 1.

3.15.5 Mitigation and Monitoring

The cumulative social and economic effects for any alternative would be positive, resulting in substantial economic benefits to both La Plata and Archuleta Counties. Therefore, we identified no mitigation measures for effects on social and economic values associated with the proposed CBM development.

3.15.6 Conformance to Existing Plans and Policies

Additional CBM development on federal leases would meet the goals for management of energy resources set forth in the LRMP for the SJNF (FS 1992) and the RMP for the San Juan/San Miguel Planning Area (BLM 1985). CBM development on private or state leases would conform to both COGCC requirements and the existing local regulations and policies.

3.15.7 Unavoidable Adverse Effects

As production would eventually decline in the NSJB Region, gas-related revenues to local governments would also decline gradually. Production-related revenues would decline in a gradual manner over a 30-year period, and so would represent less than 1 percent of the total county revenues at the end of the project.

3.15.8 Irreversible and Irretrievable Effects

There would be substantial economic benefits from any alternative to both La Plata and Archuleta Counties for the life of the project. These benefits include increased local-government revenues and employment in the region. These effects are irretrievable but are not irreversible. These effects are not irreversible because production-related revenues and project employment would cease at the end of the project. However, the positive effects from CBM-related revenues and employment would be irretrievable because they would occur for the life of the project.

3.16 Health and Safety

3.16.1 Issues

Issue 3: The effects of additional CBM development on human health and safety.

- What are the risks to human health associated with underground coal fires?
- What is the potential for contamination of drinking water aquifers by chemicals used in hydraulic fracturing and by ruptures of pipelines?
- Is hydrogen sulfide a health risk to the local community, and how will it be monitored and managed?
- What is the potential for accidental spills from generation, handling, and storage of hazardous and nonhazardous chemicals and wastes?
- What is the potential for illegal dumping of hazardous materials?
- What is the potential for fire or explosion of CBM wells?

3.16.2 Affected Environment

There is concern about the effects of additional CBM development and its potential risks to human health and safety.

Briefly, from the standpoint of human health and safety, the affected environment consists of rural development, with residences built on densities from 1 to more than 40 acres. Private land is used for agriculture (crops and grazing), as well as horse pastures and some vacant, uncultivated land. National Forest and BLM land in the Project Area provide for wildlife habitat recreation, grazing, and energy development. Two communities, Bayfield and Gem Village, are within the Project Area. A higher density of residences and businesses may be affected in these communities.

Most rural residences have shallow groundwater wells for their source of domestic water, while some have cisterns and delivered potable water.

CBM wells, pipelines, and other facilities are interspersed within the rural residential and agricultural areas. Based on setback requirements for many of the facilities, wells and pipelines cannot be installed close to residences or other public buildings.

3.16.2.1 Underground Coal Fires

Underground coal fires occur throughout the U.S. In populated areas, they can destroy property through subsidence of the ground surface and can potentially cause burns or exposure to high levels of carbon monoxide in the vented gases. If subsidence is sufficient, it could lead to collapse of structures. Subsidence is unlikely because coal fires advance slowly, but should not be ruled out as a hazard.

Dewatering of near-surface coal seams and fluctuating groundwater levels in coal beds can trigger heating and supply oxygen that may cause spontaneous combustion (BLM 1999). To date, no active coal fires have been reported in the Project Area (Keller 2001, BLM et al. 2002). Active coal fires can be identified on the surface by open fissures issuing steam and pungent odors, slump areas, active areas of mass earth movement, and dying trees and other vegetation.

Active coal fires occur on the Southern Ute Indian Reservation along the northwestern rim of the SJB, just south of the study area. These fires may be interconnected in the subsurface, but were noted in several distinct areas.

In 2000, the SUIT enlisted the services of a firm that had been successful in extinguishing coal fires in other areas. After more than $1 million had been spent, it was apparent that the problem was larger than anticipated. Considering that an additional $5 million could be required and success was not guaranteed, the mitigation efforts were abandoned because the additional expenditures would exceed the value of the coal to be saved. The fires have decreased in intensity in the areas addressed, but have also apparently shifted to other areas. Another smaller fire, apparently closer to the surface, will be attacked with bulldozers in an effort to extinguish it.

Geologic evidence, such as scoria or “Red Dog” (reddish tinted, heat-altered rocks), indicates that coal fires have occurred in prehistoric times. The scoria can be observed frequently along the outcrop of the Fruitland Formation. It commonly occurs in the Menefee Formation outcrops in La Plata County as well (for example, in Wildcat Canyon and west of Durango on Highway 160).

3.16.2.2 Contamination of Drinking Water Aquifers by Hydraulic Fracturing or Pipeline Ruptures

Hydraulic fracturing (“fracing”) is a process used in CBM development to fracture the coal bed to facilitate release of methane. Water and other fluids are mixed with sand or glass beads (proppants). The fluids and proppants are pumped into the well at high pressures, causing existing fractures to open and creating new ones. The proppants hold the fractures open. Studies have shown that hydraulic-fracturing fluids and materials remain in the coal beds, typically within 600 feet of the well bore (Diamond 1995).

In addition, the fractures have been shown to propagate almost completely within the coal beds. There is little, if any, propagation of fractures into overlying or underlying rock bodies (sandstone and shale). When fracturing is completed, the fluids are pumped back to the surface for disposal. The proppants remain in the fractures. Typically, more than 90 percent of the fluids pumped into the well bore are recovered initially. The remaining fluids either remain in the formation or are recovered after production is initiated. (See Appendix E for a complete description of the hydraulic-fracturing procedures.)

The Fruitland Formation is not considered a principal aquifer in the Project Area (Robson and Banta 1995). The Fruitland Formation is separated from the principal aquifers in the SJB by confining layers (Lewis Shale below and Kirtland Shale above).

To date, none of the constituents used in hydraulic fracturing has been documented in domestic water wells or groundwater supplies in the SJB. The EPA has reviewed hydraulic fracturing associated with oil and gas development and concluded that there is little, if any, chance for frac fluids to migrate into drinking water supplies (EPA 2002a). The EPA study was prompted by concerns from the Black Warrior Basin CBM in Alabama, where shallow coal beds were being fractured. These shallow coal beds are either within the drinking water aquifer system or just below the water supply aquifers. Coal beds in the Fruitland Formation are separated from other shallow aquifers by more than 1,000 feet of low-permeability shale and siltstone.

Residents who own domestic water wells in La Plata County have asserted that fracing a nearby CBM well has affected water wells. One landowner noted that his well, which had a depth to water of 7 feet below ground surface, began flowing water to the ground surface directly after the CBM well (700 feet distant) was artificially stimulated. His well has had continued artesian flow and is contaminated by hydrogen sulfide. Other water well owners in La Plata County have also indicated that water quality diminished after a local gas well was completed. In some cases, the impacts on water quality occur for only several days after the CBM well is completed. In other cases, however, landowners have claimed that CBM development induces a permanent change in water quality.

Several owners of domestic wells have reported that hydraulic fracturing or cavitation in nearby CBM wells has temporarily affected the water quality in domestic wells. These well owners reported that wells produced cloudy water for 3 or 4 days after work at the CBM well. It is likely that vibrations from development of the CBM well agitated water in domestic wells and loosened some of the fine-grained material in the gravel pack for the domestic well or in the well sump.

Pipelines associated with CBM development include gathering pipelines for transporting gas and produced water. Based on previous oil and gas development projects, most ruptures occur when heavy equipment accidentally strikes the pipeline or due to earth movement fracturing fiberglass pipelines during wet periods or freeze-thaw conditions. Recently, a resident of La Plata County was killed when he accidentally excavated a gas pipeline. The ruptured gas line burst into flame, burning the man severely.

Markers are posted at frequent intervals along the pipeline to prevent inadvertent excavation of pipelines and reduce the risk of accidental ruptures. Regulations require that flows in the pipeline be monitored either by remote sensors or by daily inspections of the flow meters to reduce the probability of undetected leaks or ruptures and to minimize their duration.

In a 1994, a pipeline fracture northeast of Bayfield led to high concentrations of methane in a domestic water supply nearby (BLM 1999). After the pipeline leak was repaired, the concentrations of methane in the water well decreased. Generally, pipeline leaks of any magnitude will be visible through loss of vegetation and are readily repaired. The vegetation loss appears to be temporary.

3.16.2.3 Hydrogen Sulfide

There is concern about the potential health risk of hydrogen sulfide and how it is monitored during CBM development. Because the Project Area's natural gas formation is "sweet" (does not contain sulfur compounds), hydrogen sulfide is not typically encountered during drilling in the Project Area (BLM et al. 2002, La Plata County Energy Council 2002). Samples of gas from each CBM well are collected and analyzed every 6 to 12 months during the production phase. To date, no measurable amounts of hydrogen sulfide have been detected in CBM wells in the Project Area.

Hydrogen sulfide is a toxic gas with a "rotten eggs" odor and can be lethal in concentrations above 500 parts per million (ppm) in air. It can be detected by odor at lower concentrations than laboratory equipment can analyze. Olfactory nerves become desensitized to concentrations that exceed 100 ppm within a few minutes or by long-term exposure at only 50 ppm. Therefore, odor cannot be effective for safeguarding against exposure to hazardous levels of the gas.

Within the Project Area, hydrogen sulfide gas has been measured in shallow soil vapor tubes at Carbon Junction, Pine River, and Texas Creek along the outcrop of the Fruitland Formation. Historical reports of hydrogen sulfide odor have been recorded at Carbon Junction before CBM development began. Vapor tubes on the outcrop of the Fruitland Formation on the east side of the Animas River have shown sporadic occurrences of hydrogen sulfide, with no discernible trends. The hydrogen sulfide occurs in two domestic wells at Texas Creek, one abandoned and scheduled to be plugged, and lower levels have been found in a domestic well at the Walker residence (CR 502). More than 400 ppm of hydrogen sulfide have been detected in the abandoned domestic well. These concentrations are considered hazardous, and the COGCC has flagged this well to be plugged.

Although some measurements of soil gas recorded to date show levels of hydrogen sulfide far in excess of permissible air standards, ambient air concentrations have not exceeded the OSHA 8-hour exposure concentrations of 10 ppm in air.

There are two possible mechanisms for creation of hydrogen sulfide: inorganic oxidation of sulfide minerals (such as pyrite) by near-surface recharging groundwater, and organic metabolism of sulfates by sulfate-reducing bacteria. Some occurrences of hydrogen sulfide in the Project Area are associated with coal beds and elevated concentrations of methane in shallow groundwater of the coal aquifer. Most occurrences are noted in the Gem Village area and appear to be the result of bacterial sulfate reduction indicated by isotopic analysis.

Although hydrogen sulfide has not been detected in any of the CBM wells within the Project Area, intensified methane seepage and an apparent escalation of levels of hydrogen sulfide gas were reported at historical seep sites within the Southern Ute Reservation as development of CBM gas proceeded (BLM et al. 2000). Applicable regulations at the federal, state, and La Plata County levels govern development of oil and gas on leases where the presence of hydrogen sulfide is suspected or confirmed. These regulations are described below.

If hydrogen sulfide is encountered or suspected on federal leases, monitoring the concentration (as well as other potential actions such as signage, contingency planning, etc.) is required by federal regulations in Title 43 CFR Part 3160, Onshore Oil and Gas Operations Regulations, Onshore Order 6, Hydrogen Sulfide. Under the Occupational Safety and Health Act of 1970, treatment methods or corrective measures are required during work operations when the concentration of hydrogen sulfide in ambient air exceeds 10 ppm.

COGCC Rule 607 requires that, on private or state leases, the results of air analysis for gas be reported when hydrogen sulfide is encountered. Under this rule, a drilling-operations plan for hydrogen sulfide is required as part of the APD, Form 2. This plan must be developed if concentrations of hydrogen sulfide in excess of 100 ppm can reasonably be expected to be encountered during well drilling or servicing.

A project-specific emergency preparedness plan is required under the La Plata County Land Use System (La Plata County 1997) for CBM development on private land. This plan is required for projects that involve drilling or penetration through zones of hydrogen sulfide, as determined by the county's public safety officer. The plan is to be submitted before field operations begin.

Based on discussions with the COGCC field inspectors, no related human safety incidents have been reported related to releases of hydrogen sulfide that are associated with CBM development (Weems 2002). Hydrogen sulfide gas has been noted in one CBM well on the western side of the Southern Ute Indian Reservation, south of the Project Area. No hydrogen sulfide has been measured in CBM wells in the Project Area.

3.16.2.4 Risk of Accidental Spills and Illegal Dumping

There is concern that further CBM development will increase the potential for accidental spills and illegal dumping of chemicals and hazardous wastes. A search of the COGCC database (April 2002) revealed no reported spills or releases that exceeded 5 barrels (the reportable quantity) from CBM facilities in the Project Area (COGCC 2002a). Minor spills of drilling fluids, the contents of pits, or CBM-produced waters were documented but did not require formal reporting because of the limited volumes.

No documented illegal dumping has been associated with CBM development in the Project Area (Weems 2002). Illegal dumping of hazardous materials carries severe penalties, and many materials can be traced easily. Criminal and civil penalties apply to illegal dumping, along with the associated cleanup costs and costs of emergency response. Operating companies and their contractors understand the financial and environmental risks of illegal dumping, which deters them from this activity.

These factors reduce, but do not completely eliminate, the likelihood of illegal dumping of hazardous materials. In the event that it occurs, an interagency emergency response team that is trained to contain and clean up the materials will respond. The team also investigates the illegal dumping to identify the responsible party and pursues legal action. Illegal dumping on federal land is investigated

and remediated by BLM and FS personnel trained in response and criminal investigations.

Table 2-8, "Hazardous Materials Used or Potentially Used by the Companies," lists the chemicals and hazardous materials associated with the project. Typical wastes generated during CBM development are discussed in Section 2.4.2.2, Waste Sources and Controls.

Transportation of hazardous materials is addressed in federal regulations (Title 49 CFR Parts 171–180). Under Title 40 CFR Parts 355, 370, and 372, facilities and operations that store significant amounts of chemicals must notify certain government agencies (including the EPA and state and local emergency response agencies; other agencies, such as the Coast Guard or U.S. Department of Transportation, must be notified in certain circumstances). The threshold quantity for most chemicals is 10,000 pounds. For facilities with an above ground storage capacity of more than 1,320 gallons of oil or petroleum products, the federal regulations (Title 40 CFR Part 112) require an SPCC plan. The goal of the SPCC is to prevent spills from reaching waterways. Oil spills must be reported to the U.S. Coast Guard National Response Center, as required by Title 40 CFR Part 125.

Most wastes generated at oil and gas production facilities are exempt from the RCRA regulations for hazardous wastes from point of generation to point of disposal. Compressor stations are generally small-quantity generators for hazardous wastes, producing between 100 and 1,000 kilograms per month (220 to 2,200 pounds). Spills or releases of reportable quantities that occur beyond the boundary of the facility must be reported to the EPA and appropriate local agencies, under Section 101 of CERCLA.

The operators are required to submit an Environmental and Safety Contingency Manual to the BLM for oil and gas leases on federal minerals. The procedures to contain, stop, or control the source of spills are addressed in the manual. The manual generally includes the location of spill control equipment, procedures for control of releases of hydrogen sulfide, and protocols for shutting down ignition sources in the event of a release of gas or pipeline rupture. It also must include telephone numbers for medical and emergency response personnel and agencies and procedures for handling and disposing of spilled chemicals, oils, hazardous substances, contaminated soils, or other contaminated materials.

These procedures are intended to minimize the potential for spills to contaminate surface water or groundwater. The procedures are also intended to reduce hazardous materials exposure to workers and the public. The BLM also requires the construction of containment berms around aboveground tanks to minimize the impacts of leaks and spills. Bermed areas must have 110 percent of the capacity of the tank. Moreover, the BLM requires berms around the well pad during drilling and completion to contain releases of fluids.

Wells drilled on private and state leases must comply with the standard procedures required by COGCC rules. Section 906b(1) of COGCC rules requires reporting of spills or releases of exploration and production waste or produced fluid that exceed 5 barrels, including any contained in unlined berms. Prevention

measures for spills and releases required under this rule include secondary containment for tanks that contain crude oil, condensate, or produced water with a TDS concentration above 10,000 mg/L. The COGCC rules limit the amount of materials stored near wellheads, tanks, and separators.

Under COGCC rules, a Site Investigation/Remediation Work Plan, Form 27, is required if potential adverse environmental impacts could result from a spill, or for spills that exceed 20 barrels of extraction and production waste. Any remediation required must occur in a manner to mitigate, remove, or reduce contamination in soils and groundwater to meet the allowable concentrations and levels in COGCC Table 910–1 (COGCC 2002b).

3.16.2.5 Well Fires or Explosion

There is concern about the potential for fire or explosion of CBM wells. Based on discussions with the COGCC field inspector, however, no well fires or explosions related to CBM wells have occurred in the past 15 years. The only explosion associated with CBM development was in a building enclosing a metering unit and separator unit. Apparently, gas had leaked and accumulated in the building. When the field operator arrived for the weekly inspection, his cell phone set a spark and ignited a fire. The operator sustained substantial burns but recovered.

Well fires could result from a blowout during drilling or workover, or from a gas leak during operations. Drilling operations on federal mineral leases must comply with Onshore Oil and Gas Order No. 2, Drilling (Title 43 CFR Part 3160). This rule establishes standard safety procedures for drilling and minimum blowout-prevention equipment to control abnormally high pressures if they are encountered during drilling operations.

The potential for pipeline leaks and ruptures is discussed in Section 3.16.3.2, Contamination of Drinking Water Aquifers by Hydraulic Fracturing or Pipeline Ruptures.

Well operations on federal leases are also regulated under Title 43 CFR Chapter II, Subpart 3162.5–Environmental Obligations. Approval of a drilling-and-operations plan is required as part of the well-permitting process. The plan must address the procedures to be employed for fire prevention and firefighting procedures, safety precautions, and emergency plans.

Wells drilled on private and state leases must comply with the standard safety procedures required by COGCC rules. COGCC rules include operating procedures for fire prevention and protection and a requirement that materials that are not in use but that may constitute a fire hazard be removed a minimum of 25 feet from the wellhead, tanks, and separator. Flammable liquids are not to be stored within 50 feet of the well bore, except for the fuel in the tanks of operating equipment or to supply injection pumps.

In addition, there are minimum setback distances between wells and occupied structures, and between pipelines and structures. In the event of fire, these setbacks are designed as a buffer to prevent well fires from igniting houses and injuring residents. Where pipelines are routed within densely populated areas,

American Petroleum Institute (API) standards require overall more stringent standards to protect the public. These standards include emergency shutdown systems, stronger pipe wall materials, tougher construction standards, stringent welding inspections, and other precautions that could safeguard pipeline performance in the event of a rupture.

3.16.3 Environmental Consequences

Risks to human health and safety associated with CBM development primarily apply to construction and production personnel, and, to a lesser extent, to the public. The Companies would take measures to protect public safety. These would include posting warning signs around all facilities, guardrails at pumping units, and fencing at compressor stations.

The potential impacts to human health and safety are directly tied to the issues discussed above and the risks to well site workers who are engaged in inherently hazardous activities working with high–pressure, combustible gas. Other potential impacts that were not discussed include unauthorized digging near pressurized-gas pipelines, vandalism to pipeline markers, and unauthorized persons tampering with valves and fittings at wellheads.

3.16.3.1 Underground Coal Fires

The mechanism for creating coal fires may be related to CBM development. It is well documented that spontaneous combustion can ignite underground coal beds. No known cases of coal ignition can be directly linked to CBM development in the SJB. Heat of hydration facilitates spontaneous combustion of underground coal. This heat of hydration is created when groundwater levels fluctuate. Coals most susceptible to self-heating are of high intrinsic moisture content with available oxygen, as found in low-rank coals such as sub-bituminous or lignite. Fruitland coals are low rank.

If the coal bed is an aquifer (as it tends to be in this area) and the water table fluctuates, even slightly, the heat of wetting potential is increased dramatically by removal of water. When water levels drop in unconfined aquifers (as has been observed along the Fruitland coal outcrop), ambient air is drawn into the coal beds, thus supplying the necessary oxygen to support combustion or oxidation. Once the self-heating temperature (SHT) is reached, the coal tends to produce a sustained exothermic reaction that increases oxidation until smoldering and combustion occur. The SHT can be as low as 30 degrees Celsius in lignite and sub-bituminous coals.

Because it appears that the CBM wells in the Fruitland Formation are hydraulically interconnected to some degree with the outcrop areas, a mechanism for igniting coal fires could exist. Groundwater levels in water wells and springs at the outcrop have been documented as decreasing since the 1990s. Whether known coal fires south of the Project Area have been recently ignited or only rekindled from dormant or latent smoldering fires is unknown. Whether the fires were kindled or exacerbated by the increased water withdrawal is likewise unknown. Forest fires have also been suggested as providing the spark necessary to ignite the coals.

The scoria and "Red Dog" altered rocks are evident in areas north of the boundary of the Southern Ute Indian Reservation. Therefore, it appears that coal fires have burned in times past in the NSJB. It is possible that these areas could be rekindled. Withdrawal of produced water could be a factor because the gas wells are hydraulically interconnected to the coal beds in the outcrop.

3.16.3.1.1 Alternative 1 — Proposed Action

The hydraulic interconnection between down dip gas wells and the outcrop and the geologic indicators of past coal fires in the Northern Basin suggest that the risk for ignition or re-ignition of coal fires would be in the low to moderate range and long term. If fires were ignited, commensurate gas vents, fissures, and collapse features could be anticipated. Public exposure to gas vents could lead to carbon monoxide poisoning, burns (vented gases are extremely hot), and possible collapse of the overburden. As noted above, it is unlikely that a catastrophic and unpredicted collapse of inhabited structures would occur because of the slow progress of coal fires.

Typically, coal fire vents are localized, but their locations cannot be predicted. Therefore, any new coal fires would require close monitoring and possible restricted access to the affected area. People unaware of the possible dangers associated with coal fires may be the first to encounter a new fire. Given land ownership patterns on the outcrop of the Fruitland Formation within the Project Area, it is likely that private citizens could be the first to encounter any new coal fires.

3.16.3.1.2 Alternative 2

The risk of igniting a coal fire would increase commensurately with the increased proximity of CBM wells to the outcrop. An increased potential for decreasing the water table near the outcrop would exist. Risks would increase to moderate and long term. Hazards to public health are as described in Alternative 1.

3.16.3.1.3 Alternative 5 — No Action

Fewer CBM wells and associated facilities would be installed under this alternative compared with the other alternatives; the potential risk to human health and safety from underground coal fires would be similar, however, to Alternative 1.

3.16.3.1.4 Alternative 6

The risk of igniting a coal fire would decrease commensurately with a decreased number of CBM wells within proximity to the Fruitland Formation outcrop. Risks would be low and long term. Hazards to public health are as described in Alternative 1

3.16.3.1.5 Alternative 7

The risk of igniting coal fires would be low and long-term as a result of implementing Alternative 7. Potential impacts are as described in Alternative 1. However, development of private mineral estate within the 1½-mile-near-Fruitland-Outcrop zone may serve as an effective predictor of hydrologic interaction between wells drilled within the outcrop zone and the outcrop coal beds. Development of federal leases within 1½ miles of the outcrop in the eastern Project Area would proceed after private mineral estate development and would be condi-

tioned by monitoring information obtained from private mineral estate development. Well conditions of approval would incorporate requirements that provide for protection of health, safety, and property.

3.16.3.2 Contamination of Drinking-Water Aquifers by Hydraulic Fracturing or Pipeline Ruptures

Two issues are discussed in this section: the possible contamination of shallow aquifers from hydraulic fracturing, and contamination by leaking pipelines (either gas or produced-water pipelines). Other hazards are posed by ruptured gas pipelines, such as fires, explosions, and severe burns.

3.16.3.2.1 Hydraulic Fracturing

Fractures that propagate from the well bore terminate within approximately 600 feet. In addition, the petrophysical properties of coals interbedded with shale and sandstone serve to isolate most of the fractures within the coal beds (Diamond 1995). After fracturing, the fluids used to slurry the proppants (sand or glass balls) are pumped back out of the formation. Typically, about 90 percent of the fluids are recovered during this phase of well development. Hydraulic fracturing is discussed in detail in Appendix E.

Typically, the exploitable coal beds in the Fruitland Formation are found at depths greater than 1,200 feet below the ground surface. The intervening Kirtland Shale and shallower formations provide sufficient hydraulic separation between the fractured coal beds and the shallow aquifers to preclude migration of frac fluids into the shallow aquifers. In addition, a zone of low pressure is established in the Fruitland Formation around the well bore once a well is completed and begins producing. Within this zone, flow of fluid is to the point of lowest pressure, the well bore. Therefore, there is little possibility during the production phase that the unrecovered frac fluids could migrate into shallower aquifers.

In 2002, the EPA completed an exhaustive study to evaluate whether hydraulic fracturing should be regulated through the UIC well program. The EPA's study was focused on cases where hydraulic fracturing in oil and gas wells contaminated domestic drinking water wells. EPA could find no case where domestic well contamination could be linked to hydraulic fracturing in nearby oil and gas wells. The EPA, however, cautioned investigators that the possibility of contamination should not be ignored, particularly where geologic conditions do not provide the degree of separation between the oil-and-gas-producing zones and the drinking-water aquifer. The geologic conditions in the Project Area provide sufficient separation, with the exception of areas near the outcrop, which are considered uneconomic for CBM development.

3.16.3.2.2 Pipeline Ruptures

The Bureau of Transportation Statistics (BTS) reports an average of one safety incident (including ruptures) per year per 5,455 miles of pipeline in the U.S. (BTS 2002). There are currently 196 miles of pipelines (gathering and trunk line) within the Project Area. A maximum of 203 additional miles of pipelines would be installed under the maximum-development scenario of Alternative 2, for a total of 399 miles of pipelines. Applying the BTS assumption of one safety inci-

dent per year for every 5,455 miles of pipeline, and assuming that this incident rate is industry standard and the pipelines within the Project Area meet or exceed industry standards, we could expect one safety incident every 24 years. Because the expected lifetime of the project is 25 to 30 years, one safety incident could thus be expected over the lifetime of the project.

There has been one known case in La Plata County where a leaking methane pipeline has contaminated a nearby water well. When the pipeline leak was repaired, the concentration of methane in the affected well quickly diminished.

No cases of leaking produced-water pipelines affecting water wells have been documented to date.

The alternatives call for increasing density and linear footage of gas and water pipelines, and would increase the potential for pipeline ruptures that may affect water wells. The greater the number of pipelines, the greater the chance ruptures could occur.

The potential for pipeline ruptures increases as the pipelines age. Corrosion, both internal and external, can weaken the pipe wall, making it susceptible to rupture or leaks. Operators in the Project Area conduct a maintenance program that checks the integrity of pipelines on a regular schedule, per API standards. When corrosion or leaks are detected, they are repaired immediately.

3.16.3.2.3 Alternative 1 — Proposed Action

Alternative 1 would increase the potential that drinking water wells may be contaminated by pipeline leaks because of increased pipeline numbers and aging of the existing pipelines.

Based on a large body of evidence (Diamond 1995, EPA 2002a) it is considered unlikely that water wells would be contaminated by hydraulic fracturing.

3.16.3.2.4 Alternative 2

Alternative 2 would involve installation of a larger number of CBM wells and more miles of pipelines compared with the other alternatives.

The risk of contamination of drinking water aquifers by hydraulic fracturing or pipeline ruptures would be higher than that for Alternative 1 because of the additional pipelines. CBM wells drilled near the outcrop, where the Fruitland Formation is fairly shallow, would increase the potential for hydraulic fracturing to contaminate shallow aquifers would increase.

3.16.3.2.5 Alternative 5 — No Action

Under this alternative, there would be a smaller number of CBM wells and fewer miles of pipelines (for both gas and production water) compared with the other alternatives. Therefore, the potential for contaminating shallow aquifers is reduced, although the risks are already low.

3.16.3.2.6 Alternative 6

The potential risk of contaminating drinking water aquifers through hydraulic fracturing or pipeline ruptures would be similar to that for Alternative 1 on the project's west side. The level of development within rural residential areas would be lower than Alternative 1 within the project area's east side; therefore, risks of well contamination would be lower.

3.16.3.2.7 Alternative 7

The effects from hydraulic fracturing would be the same as Alternative 1 due to number of wells drilled within proximity of domestic water wells. Based on a large body of evidence (Diamond 1995, EPA 2002a), it is considered unlikely that water wells would be contaminated by hydraulic fracturing.

3.16.3.3 Hydrogen Sulfide

Within the Project Area, hydrogen sulfide is common in areas internal to the San Juan Basin Rim, most notably in the Gem Village area, Dry Creek, along CR #225, and in the Piedra River drainage in the area around Stollsteimer Creek. Along the Fruitland Formation outcrop, hydrogen sulfide exists in several domestic water wells between Texas Creek and the Pine River Ranches Subdivision as well as in several soil vapor tubes, notably in the Carbon Junction area near Durango.

Just north of the Fruitland outcrop (and this Project Area), domestic water wells in the Mesa Verde Formation show considerable hydrogen sulfide concentrations. In the NSJB, but south of the Project Area, notable hydrogen sulfide is recognized in the Bondad/Sunnyside area internal to the Southern Ute Indian Reservation and in one gas well in the northwestern edge of the Basin. Numerous soil vapor tubes in the Fruitland outcrop on Reservation lands to the south show concentrations in excess of 2,000 ppm in subsurface soil gas. Rarely does the ambient air even then approach the OSHA 10 ppm threshold.

Existing hydrogen sulfide emissions are limited to one shallow well on the northwestern flank of the SJB, one shallow domestic well on the outcrop, and several shallow soil vapor tubes on the northern basin outcrop. Hydrogen sulfide appears to occur in near-surface regimes in the Fruitland Formation coal beds, particularly in areas subject to larger quantities of recharging groundwater. Because the overwhelming majority of CBM wells do not contain hydrogen sulfide, the risk of exposure is extremely low.

Although the risks of exposure are extremely low at this time, the BLM and COGCC maintain ongoing outcrop-monitoring programs. The monitoring occurs throughout the year, and changes in conditions at the outcrop are observed, recorded, and mapped. In the event that hazardous conditions are observed, the safety requirements under oil and gas order No. 6 will be implemented, including reporting to the private landowner, along with safety measures the landowner and general public must observe around hazardous areas.

In the event that conditions change within the reservoir of the Fruitland Formation, or if hydrogen sulfide is encountered in wells drilled in undeveloped regions of the Project Area, the standard safety procedures must be followed for releases

of hydrogen sulfide at drilling operations. Employee training is required for emergency response, including monitoring for hydrogen sulfide. If hydrogen sulfide is encountered or suspected, a contingency plan is required and treatment or corrective measures must be implemented if the concentrations exceed the regulatory standard.

3.16.3.3.1 Alternative 1 — Proposed Action

Because existing monitoring data show the absence of hydrogen sulfide in deeper coal beds, there is low probability that hazardous levels will be encountered by implementing Alternative 1. However, it is possible that "nuisance" non-hazardous levels of hydrogen sulfide may occur along the outcrop areas in the eastern portion of the Project Area as the groundwater table is drawn down due to increased CBM production.

Additional data on ambient air quality show that concentrations of hydrogen sulfide in La Plata County have never been documented at concentrations over the OSHA permissible-exposure limit of 10 ppm. Even in areas such as Carbon Junction, where hydrogen sulfide odors are evident, EPA monitoring has shown levels several orders of magnitude lower than the OSHA permissible exposure limit.

3.16.3.3.2 Alternatives 5, 6, and 7

Similar to the potential impacts described for Alternative 1, the risks to human health and safety from hydrogen sulfide are extremely low.

3.16.3.3.3 Alternative 2

Similar to the potential impacts described for Alternative 1, the risks to human health and safety from hydrogen sulfide are extremely low. However, because hydrogen sulfide occurs near the outcrop of the Fruitland and larger number of wells would be drilled nearer the outcrop under Alternative 2 compared with Alternative 1, the risks of exposure to hazardous levels of hydrogen sulfide would be marginally greater.

3.16.3.4 Accidental Spills and Illegal Dumping

Federal regulations require tracking of chemicals and hazardous materials. Threshold volumes (reportable quantities) are defined in the federal regulation (40 CFR 302). These regulations cover transportation, storage, use, and disposal of chemicals, hazardous materials, and wastes.

Based on the history of the Project Area, the operators comply with the federal regulations to prevent and control spills and manage wastes. The chemicals, hazardous materials, and wastes typically associated with CBM development for any of the alternatives are listed on Table 2-8.

The companies are required to develop plans for all potential emergencies, including chemical releases or spills. Employee training is required on the emergency plan. Under Section 101 (14) of CERCLA and 40 CFR 125, spills or releases of reportable quantities of hazardous substances that occur beyond the boundary of the facility must be reported to the EPA, the National Response Center, and appropriate local agencies.

Several operators have established more stringent reporting requirements than required by regulations. For example, one large operator requires field personnel to report releases of 1 gallon of produced water, even on the well pad, when regulations require reporting releases of produced water that exceed 10 barrels. This stringent tracking of small releases allows the Companies to identify the work processes that require improvement to reduce the risk of spills.

As described above, there have been few cases of illegal dumping by the operators on the Project Area.

3.16.3.4.1 Alternative 1 — Proposed Action

The risk of an accidental spill would be proportionate to the amount of chemicals and hazardous materials transported, stored, and used in the Project Area. The operator's continued adherence to regulations and its own environmental-health-and-safety plans will minimize the potential for spills and illegal dumping of hazardous materials.

3.16.3.4.2 Alternative 2

A larger number of CBM facilities is associated with this alternative compared with the others. Because this alternative would increase the amount of chemicals and hazardous materials used or generated during operations, the potential for spills and illegal dumping increases when compared with Alternative 1 or other alternatives. The potential for human health-and-safety effects from accidental spills or illegal dumping of chemicals, hazardous materials, and wastes remains low if operators continue to adhere to their plans and the existing regulations.

3.16.3.4.3 Alternative 5 — No Action

A smaller number of CBM facilities is associated with this alternative compared with the other alternatives. Therefore, the risk of spills and illegal dumping would be lower than Alternative 1.

3.16.3.4.4 Alternative 6

A smaller number of CBM facilities is associated with this alternative compared with the other alternatives. Therefore, the risk of spills and illegal dumping would lower than Alternatives 1 and 2.

3.16.3.4.5 Alternative 7

The amount of chemicals and hazardous materials transported, stored, and used would be slightly lower that Alternative 1 because 47 fewer wells would be drilled on National Forest in the Project Area. Therefore, the probability of accidental spills and illegal dumping would be slightly less than Alternative 1.

3.16.3.5 Well Fire or Explosion

Standard safety procedures for well drilling, pipeline markers, monitoring, and inspections are required by federal and state regulations to minimize the probability of a well blowout, undetected gas leak, or well fire. Regulations require that well sites be kept free of vegetation and trash to minimize the potential for fires. The Companies are required to develop an emergency plan with defined

fire prevention and firefighting procedures and telephone numbers for emergency services and contacts. This emergency plan must be posted at field facilities. Emergency response plans require employee and contractor training to respond to well fires and explosions.

In addition, BLM and COGCC inspectors witness testing of key safety equipment annually. For example, blowout preventers (BOPs) are tested for their pressure-rated performance, and these tests are witnessed by qualified inspectors to ensure the integrity of the equipment.

The BLM and COGCC review the operator's drilling plans and geologic conditions before they approve an APD. These reviews consider the reservoir pressures that may be encountered, compare these pressures with the operator's proposed equipment ratings, casing design, and cement program. Final approval is granted after the appropriate engineering checks are completed and the appropriate safety factors are confirmed.

The witnessing in the field and the pre-field engineering and geologic reviews are performed to avoid blowouts and well fires. These checks do not guarantee the integrity of the equipment, nor can they consider every potential geologic hazard that may be encountered. Therefore, well explosions and blowouts are considered a possible risk. Again, the operator's emergency plans consider these situations; the personnel are trained to respond, and the county emergency response crews are also trained to respond to these emergencies.

The Association of Mechanical Engineers (ASME) and API issue standards for the design, construction, installation, and maintenance of pressure vessels, fittings, piping, and pipelines. Operators and their contractors build, operate, and maintain all equipment and pipelines according to these standards intended to minimize the potential for explosions and failure of the equipment. For example, API publishes standards on corrosion coatings for buried pipelines. These standards specify coating materials, material thickness, test procedures to ensure that coatings are applied properly, test procedures to ensure that no holes are in the coating, acceptance criteria, and handling/installation procedures once the pipeline is coated and leaves the mill. Similar standards apply to all material and equipment used by the operators.

The risk of well fires and pipeline explosions posed by wildfires is very low. Buried pipelines present a low risk for explosion in the event that a wildfire overruns the pipeline. Numerous wildfires have burned over buried pipelines in the Western U.S. and there are no reports of pipeline explosions resulting from these events. Wellheads and equipment are buffered by the bare ground of the well pad, which reduces exposure of this equipment to heat. In addition, operators have emergency shutdown plans in place in the event a wildfire threatens to overrun operating wells. Emergency shutdown can be implemented within minutes in most cases.

As with all construction, all potential for human error cannot be eliminated. Thus, emergency response plans and training programs are required.

3.16.3.5.1 Alternative 1 — Proposed Action

Assuming that the operators, the BLM, and the COGCC implement the required safety procedures, and that reviews and inspections are performed, the 284 proposed CBM wells and associated facilities would pose a low risk for well fires or explosions.

3.16.3.5.2 Alternative 2

Because this alternative proposes more wells and pipelines, the potential for an explosion or well fire is higher than with Alternative 1. Although the potential remains low, the risk of equipment failure increases with the larger number of pipes, fittings, separators, and other equipment.

3.16.3.5.3 Alternative 5 — No Action

Because fewer wells would be drilled, the risk for well fires or explosions would be lower for this alternative compared with Alternatives 1 and 2.

3.16.3.5.4 Alternative 6

Because fewer wells would be drilled, the risk for well fires or explosions would be lower for Alternative 6 compared with Alternatives 1 and 2.

3.16.3.5.5 Alternative 7

As compared to Alternative 1, Alternative 7 would result in 47 fewer wells drilled on National Forest. This commensurate reduction in number of wells drilled would reduce the potential for well fires and explosions when compared to Alternative 1.

3.16.4 Cumulative Effects

The analysis of cumulative human health and safety effects considers the existing and proposed development in the project plus the existing level of development approved in the SUIT FEIS (BLM et al. 2002). The SUIT FEIS analyzed development of 636 conventional and CBM gas wells and associated facilities on Tribal minerals and 519 CBM wells on non-tribal minerals within the bounds of the Southern Ute Reservation.

3.16.4.1 Underground Coal Fires

Under Alternative 1, the risk of underground coal fires from the cumulative 1,439 new gas wells (284 in the Project Area and 1,155 in the SUIT Project Area) would be moderate and long-term; however, coal fires are unlikely to pose a risk to human health and safety.

The effects on human health and safety as a result of underground coal fires associated with the cumulative CBM development under Alternatives 2 and 7 are similar to those for Alternative 1. For Alternatives 5 and 6, a smaller cumulative number of CBM wells and associated facilities would be installed in the Project Area compared with the other alternatives; the effects on human health and safety associated with underground coal fires would be similar, however, to those of Alternative 1.

3.16.4.2 Contamination of Drinking Water Aquifers by Hydraulic Fracturing or Pipeline Ruptures

For Alternative 1, the cumulative effects of 1,439 new gas wells would pose a low potential risk of contamination of drinking water aquifers by hydraulic fracturing. The cumulative miles of pipelines (both for natural gas and production water) associated with gas development would not be likely to affect drinking water aquifers in the event of a probable pipeline incident that could occur one time in 12 years. Alternative 7 would be similar to Alternative 1 in terms of risk.

The lower cumulative number of new CBM wells and miles of pipeline associated with Alternatives 5 and 6 would pose a slightly lower risk of contamination of drinking water aquifers by hydraulic fracturing or pipeline ruptures compared with Alternative 1.

Under Alternative 2, the cumulative effects of the 1,677 new gas wells (522 in the Project Area and 1,155 in the SUIT Project Area) would pose a slightly higher, but still low, potential risk of contamination of drinking water aquifers by hydraulic fracturing. The cumulative miles of pipelines (both for natural gas and production water) associated with gas development would not be likely to affect drinking water aquifers in the event of a pipeline incident that could occur one time in 10 to 12 years.

3.16.4.3 Hydrogen Sulfide

Given the extremely low risk of hydrogen sulfide to human safety from individual wells, potential cumulative impacts are anticipated to be extremely low.

3.16.4.4 Accidental Spills and Illegal Dumping

Under Alternative 1, the cumulative total of 1,439 new CBM wells and associated facilities would pose a minor risk of accidental spills. Assuming that the operators would implement the required emergency response plans and procedures, it is unlikely that human health and safety would be affected by spills or illegal dumping of chemicals, hazardous materials, or wastes from the cumulative CBM development associated with this alternative.

The cumulative effects of Alternative 2 would be a slightly higher risk of accidental spills and illegal dumping because of the additional 230 CBM wells in the Project Area. The potential for effects on human health and safety would be low and similar to those of Alternative 1. Under Alternatives 3 and 4, the cumulative potential for effects on human health and safety from accidental spills or illegal dumping of chemicals, hazardous materials, or wastes would be low and similar to those of Alternative 1.

Under Alternative 5, there would be fewer new CBM wells and associated facilities. Therefore, the potential for human health-and-safety effects from accidental spills or illegal dumping of chemicals, hazardous materials, or wastes would be lower cumulatively compared with Alternative 1.

Under Alternatives 6 and 7, the cumulative probability of accidental spills and illegal dumping would be equivalent to that of Alternative 1.

3.16.5 Mitigation and Monitoring

3.16.5.1 Coal Fires

Because much of the outcrop of the Fruitland Formation is on public and undeveloped private land, the danger from coal fires to the public is reduced. Physically hazardous areas of fissures and potential soil collapse could be cordoned off. Few homes exist on the Fruitland coal beds at the outcrop. Possible mitigation in the event of coal fires could include measures to extinguish the fires, but this has been shown to be impracticable in nearby areas. Early detection through ongoing Fruitland outcrop monitoring efforts could result in mobilization of heavy equipment to excavate and extinguish new coal fires before they become unmanageable.

3.16.5.2 Hydrogen Sulfide

Because current COGCC Rule 607, the La Plata County Land Use Code, Oil and Gas Order No. 6, and OSHA regulations adequately address potential hydrogen sulfide risks to human health and safety, no further mitigation measures are necessary.

3.16.5.3 Stage 2 Fire Orders

When fire conditions are extreme, the BLM, FS, La Plata County, and Archuleta County issue fire orders to the operators to reduce the potential for wildfires caused by oil and development.

3.16.5.4 Industry Procedures

The following documents produced by the API and ASME describe procedures that provide a safe and effective CBM operation in the Northern San Juan Basin:

API Documents

API Exploration Oil Field Equipment and Materials

API Exploration Series 4: Derricks and Masts

API Exploration Series 5: Tubular Goods

API Exploration Series 6: Valves and Wellhead Equipment

API Exploration Series 7: Drilling Equipment

API Exploration Series 8: Hoisting Tools

API Exploration Series 9: Wire Rope

API Exploration Series 10: Oil Well Cements

API Exploration Series 11: Production Equipment

API Exploration Series 12: Lease Production Vessels

API Exploration Series 13: Drilling Fluid Materials

API Exploration Series 15: Fiberglass and Plastic Pipe

API Exploration Series 16: Drilling Well Control Systems

API Exploration Series 19: Completion Equipment

API Exploration Drilling and Production Operations: Recommended Operating Practices

API Exploration Health, Safety, and Environment (Naturally Occurring Radioactive Materials)

API Exploration Health, Safety, and Environment (Safety and Fire Protection)

API Exploration Health, Safety, and Environment (Waste)

API Pipeline Transportation Pipeline Operations

API Safety and Fire Protection

API Storage Tanks

API Health and Environmental Issues—Pollution Prevention

API Industry Training—Exploration and Production

ASME Documents

An Engineer's Guide to Pipe Joints

Integrity of Structures and Fluid Systems, Piping and Pipe Supports, and Pumps and Valves

Components Analysis and Evaluation Aging and Maintenance and Pipe Supports

Pressure Surges Safe Design and Operation of Industrial Pipe Systems

Integrity of Structures and Fluid Systems, Hazardous Protection, Piping and Pipe Supports, Pump, Valves

Metallic Gaskets for Pipe Flanges

Ground and Cut Threads

Gas Transmission and Distribution Piping

Nonmetallic Flat Gaskets for Pipes Flanges

Managing System Integrity of Gas Pipelines

Process Piping

Boiler and Pressure Vessel Code

Pipeline Protection

Graphical Symbols for Diagrams; Basic mechanical Components

Determining remaining Strength of Corroded Pipelines: Supplement to Code-Pressure Piping

Scheme for the Identification of Piping Systems

3.16.6 Conformance to Existing Plans and Policies

Further CBM development in the NSJB would conform to the applicable federal, COGCC, and local health and safety laws and regulations. The regulations and rules applicable to CBM development are summarized in Section 2.4.

3.16.7 Unavoidable Adverse Effects

During the life of the project, there would be some additional human health and safety risks associated with construction and operation of CBM facilities in the Project Area. These risks would primarily be short term during the construction phase of the CBM development. However, there would be long-term risks associated with the presence of natural gas in the Project Area. CBM-related health and safety risks would primarily apply to the companies' personnel and, to a lesser degree, the public.

3.16.8 Irreversible and Irretrievable Effects

During the life of the project, there would be some additional human health and safety risks associated with CBM development in the Project Area. CBM-related health and safety risks would primarily apply to the companies' personnel and, to a lesser degree, the public. These effects would be irreversible but not irretrievable. Following successful reclamation, the materials, equipment, and facilities that could pose a CBM-related health and safety risk would be removed from the Project Area.

3.17 Air Quality and Climate

3.17.1 Issues

Public concerns raised during the scoping process for the EIS included: 1) The effects of additional CBM development on human health and safety and 2) The effects of additional CBM development on air quality and visibility.

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (separation and dehydration heaters, pipeline compression engines, and small well-head engines), are potential causes of air quality impacts. These sources of air pollution are more likely to become public issues where natural gas development activities occur near residential areas. The USDI-National Park Service (NPS) and the FS have also expressed concerns regarding potential atmospheric deposition (acid rain) and visibility impacts within mandatory federal Prevention of Significant Deterioration (PSD) Class I areas under their administration (Mesa Verde National Park and the Weminuche Wilderness Area).

3.17.2 Affected Environment

The air quality of any region is controlled primarily by the magnitude and distribution of pollutant emissions and the regional climate. The transport of pollutants from specific source areas is strongly affected by local topography. In the mountainous western United States, topography is particularly important in channeling pollutants along valleys, creating upslope and downslope circulation that entrain airborne pollutants, and blocking the flow of pollutants toward certain areas. In general, local effects are superimposed on the general synoptic weather regime and are most important when the large-scale wind flow is weak.

3.17.2.1 Topography

The Project Area is located in the northern portion of the SJB in southwestern Colorado (Figure 1–1). The topography of the Project Area varies from moderately steep to steep mountains, canyons, and mesas in the north-central and south-central portions, to rolling hills and gently sloping river valleys in the eastern and western regions. Elevations range from about 6,000 to nearly 9,000 feet. The Air Quality Impact Analysis Area (Figure 3–84) is larger, encompassing nearly 12,600 square miles of both northwestern New Mexico and southwestern Colorado.

3.17.2.2 Climate and Meteorology

The Project Area is primarily pinion-juniper woodland at elevations from 6,000 to 7,200 feet with average annual precipitation between 13 to 17 inches, and pinion-juniper/mountain browse at elevations from 6,100 to nearly 9,000 feet with average annual precipitation 14 to 20 inches.

Temperature and precipitation data obtained from the Western Regional Climate Center (WRCC) for Ignacio, Colorado, are considered to be representative of climatic conditions within the Project Area (WRCC 2003). However, because

elevation, slope, and aspect affect precipitation and temperatures, the complex terrain results in considerable climatic variability. For the period of 1971 through 2000, annual precipitation measurements at Ignacio averaged 14 inches. Precipitation is typically well distributed throughout the year at nearly one inch per month, with June receiving the lowest average amounts (nearly 0.5 inch) and August the highest levels (1.7 inches). December and January were the coldest months, with average lows of about 10 °F (degrees Fahrenheit) and highs of about 40 °F. The warmest months were July and August with average minimum and maximum temperatures of 50 °F and 85 °F, respectively.

Representative wind measurements are limited within the Analysis Area. Meteorological data collected during 2002, adequate to represent local air pollutant dispersion and transport adjacent to wells and compressor stations (near-field), were obtained from the BP America Inc. Natural Gas Processing Plant located near Bayfield, Colorado. Meteorological data adequate to represent regional air pollutant dispersion and transport throughout the Analysis Area was obtained from the 1990 MM4 (Pennsylvania State University/National Center for Atmospheric Research Mesoscale Model Version 4) and the California Meteorological Model (CALMET) data set, as previously used in the SUIT Oil and Gas EIS (BLM 2000d).

3.17.2.3 Existing Air Quality

Although specific air quality monitoring is not conducted throughout most of the Analysis Area, air quality conditions are likely to be very good, as characterized by few air pollution emission sources (limited industrial facilities and few residential emissions, primarily from smaller communities and isolated ranches), good atmospheric dispersion conditions, as well as limited air pollutant transport into the Analysis Area, resulting in relatively low local air pollutant concentrations.

Known contributors to pollutant levels within the Project Area include the following:

- exhaust emissions (primarily carbon monoxide [CO] and oxides of nitrogen [NO_x]) from existing natural gas fired compressor and small wellhead engines, plus gasoline and diesel vehicle tailpipe air pollutants (CO, NO_x, particulate matter less than 2.5 microns in effective diameter [$PM_{2.5}$], particulate matter less than 10 microns in effective diameter [PM_{10}], sulfur dioxide [SO_2], and volatile organic compounds [VOC]).
- dust (particulate matter) generated by vehicle travel on unpaved roads, windblown dust from disturbed lands, and road sanding during the winter months.
- limited transport of air pollutants from emission sources located outside the Project Area.

The most complete air quality monitoring data available within the Analysis Area are from the SUIT operated station near Ignacio, Colorado, which has provided continuous measurements since 1987, and are considered to be the best available representation of background air pollutant concentrations throughout the Analysis Area (RTP Environmental 2004). These data (reported in micrograms per cu-

bic meter, or μg/m³) were used to define background conditions (Table 3–188), and include impacts from existing sources both inside and outside the Analysis Area. The maximum pollutant concentrations recorded at Ignacio are well below applicable Colorado and National Ambient Air Quality Standards (NAAQS) for most pollutants, although maximum concentrations of ozone approaching the federal standard have been observed. Given the episodic nature of observed high ozone levels, their cause is uncertain, although regional transport or subsidence of stratospheric ozone is possible. These data are also consistent with estimated baseline concentrations provided by the Colorado Department of Public Health and Environment-Air Pollution Control Division (CDPHE-APCD) for rural southern Colorado, including estimated baseline levels for CO (1-hour and 8-hour), ozone (8-hour), and $PM_{2.5}$ (24-hour and annual).

Table 3–188 Assumed Background Concentrations of Regulated Air Pollutants

Pollutant	Averaging Time	Maximum Concentration (μg/m³)	Second Max Concentration (μg/m³)	NAAQS(1) (μg/m³)
Carbon Monoxide	1-hour	2,300	2,300	40,000
	8-hour	2,300	2,300	10,000
Nitrogen Dioxide	Annual	9	N/A(2)	100
Ozone	1-hour	164	163	235
	8-hour	137(3)	N/A	157
$PM_{2.5}$	24-hour	26	20	65
	Annual	6	N/A	15
PM_{10}	24-hour	50	25	150
	Annual	15	N/A	50
Sulfur Dioxide	3-hour	57	55	700(4)
	24-hour	23	23	365
	Annual	2	N/A	80

Notes:

(1)Annual standards are not to be exceeded; short-term standards are not to be exceeded more than once per year.

(2)N/A = not applicable.

(3) The applicable "maximum" 8-hour ozone concentration represents the 3-year average of the fourth highest measured annual concentrations, as specified in the NAAQS regulations.

(4) The applicable CDPHE-APCD standard of 700 μg/m³ is more stringent than the NAAQS of 1,300 μg/m³.

Source: RTP Environmental 2004

Although the available Ignacio monitoring data adequately represent regional background conditions, they do not represent conditions immediately adjacent to large existing natural gas-fired emission sources (for example, compressors and small well-head engines) within the Analysis Area. Therefore, the near-field air quality impact dispersion modeling analysis explicitly included these existing sources, in addition to other reasonably foreseeable future development emission sources.

3.17.2.4 Regulatory Framework

The EPA establishes and revises the NAAQS as necessary to protect public health and welfare, setting the absolute upper limits for specific air pollutant concentrations at all locations where the public has access. Although the EPA recently revised both the ozone and $PM_{2.5}$ NAAQS, these revised limits will not be implemented by the CDPHE-APCD until the Colorado State Implementation Plan is formally approved by EPA; until then, EPA is responsible for implementing these revised standards. This analysis of potential CBM development impacts must demonstrate compliance with all applicable local, state, tribal, and federal air quality standards.

Air pollution impacts would be limited by local, state, tribal and federal regulations, standards, and implementation plans established under the CAA and administered by the CDPHE-APCD (with EPA oversight). Air quality regulations require proposed new, or modified existing, air pollutant emission sources (including natural gas development facilities) undergo a permitting review before their construction can begin. Therefore, the CDPHE-APCD has the primary authority and responsibility to review permit applications and to require emission permits, fees and control devices, prior to construction and/or operation.

In addition, the U.S. Congress (through the CAA Section 116) authorized local, state and tribal air quality regulatory agencies to establish air pollution control requirements more (but not less) stringent than federal requirements (such as Colorado's 3-hour SO_2 ambient air quality standard). Additional site-specific air quality analysis would be performed, and additional emission control measures (including a Best Available Control Technology or BACT analysis and determination) may be required by the applicable air quality regulatory agencies to ensure protection of air quality resources. In addition, under the federal CAA and Federal Land Policy and Management Act (FLPMA), federal agencies can not authorize any activity which does not conform to all applicable local, state, tribal and federal air quality laws, statues, regulations, standards, and implementation plans.

The existing air quality of the Project Area is in attainment with all ambient air quality standards, as demonstrated by the relatively low concentration levels presented in Table 3–188 above. Given the Project Area's current attainment status, future development projects (under any Alternative) which have the potential to emit more than 250 tons per year (or certain listed sources that have the potential to emit more than 100 tons per year) of any criteria pollutant would be required to submit a pre-construction PSD Permit Application, including a regulatory PSD Increment Consumption Analysis under the federal New Source Review and permitting regulations. Development projects subject to the PSD regulations must also demonstrate the use of BACT and show that the combined impacts of all applicable sources will not exceed the PSD increments for nitrogen dioxide (NO_2), PM_{10}, or SO_2. Finally, the permit applicant must demonstrate that cumulative impacts from all existing and proposed sources would comply with the applicable ambient air quality standards throughout the operational lifetime of the permit applicant's project.

In addition, a regulatory PSD Increment Consumption Analysis may be conducted at any time by the CDPHE-APCD or EPA, in order to demonstrate that the applicable PSD increment has not been exceeded by all applicable major or minor increment consuming emission sources. The determination of PSD increment consumption is a legal responsibility of the applicable air quality regulatory agency (with EPA oversight).

For example, the CDPHE-APCD (1999) conducted a detailed review of NO_2 PSD increment consumption in southwest Colorado, indicating that Class I increment values "are probably not violated" at the Mesa Verde National Park or the Weminuche Wilderness Area, but that preliminary results "suggest that there is one isolated hot spot in La Plata County where there is an apparent Class II PSD increment violation." The CDPHE-APCD worked closely with the emission source operator to better understand the specific situation, and has resolved this suspected source-specific PSD Class II increment situation.

Mandatory federal Class I areas were designated by the U.S. Congress on August 7, 1977, including those existing wilderness areas greater than 5,000 acres in size and national parks greater than 6,000 acres in size. All other locations in the country were ambient air quality is within the NAAQS (including attainment and unclassified areas) were designated as PSD Class II areas with less stringent requirements. In addition, sources subject to the PSD permit review procedures are required to demonstrate that impacts to Air Quality Related Values (AQRV) will be below Federal Land Managers' Air Quality Related Values Work Group (FLAG) "Limits of Acceptable Change" (FLAG 2000). The AQRVs to be evaluated include degradation of visibility, deposition of acidic compounds in mountain lakes, and effects on sensitive flora and fauna within the PSD Class I areas. For example, the FS San Juan National Forest Supervisor and Rocky Mountain Regional Forester are the Federal Land Managers directly responsible for the lands within the Weminuche Wilderness Class I area. Under the Clean Air Act, they are charged with "… an affirmative responsibility to protect the air quality related values (including visibility) of any such lands within a class I area…"

Therefore, most of the Analysis Area is currently designated as PSD Class II, while Mesa Verde National Park and the Weminuche Wilderness Area are protected by more stringent NO_2, PM_{10}, and SO_2 PSD Class I increment thresholds, as shown in Table 3–189.

Table 3–189 Applicable PSD Increment Values

Pollutant	Averaging Time	PSD Class I Increments ($\mu g/m^3$)	PSD Class II Increments ($\mu g/m^3$)
Nitrogen Dioxide	Annual	2.5	25
PM_{10}	24-hour	8	30
	Annual	4	17
Sulfur Dioxide	3-hour	25	512
	24-hour	5	91
	Annual	2	20

Source: RTP Environmental 2004

In addition, the CDPHE-APCD also requires various different pre-construction and operation permits, including: 1) any emission source with the potential to emit air pollutants in excess of 2 tons per year must submit an Air Pollution Emission Notice to CDPHE-APCD; 2) all emission sources with the potential to emit NO_x or CO in excess of 10 tons per year, or 5 tons per year of PM_{10}, are required to obtain a permit before construction can begin; 3) sources with potential emissions in excess of 100 tons per year of CO, 40 tons per year of NO_x, or 15 tons per year of PM_{10}, must also include a new source modeling analysis in their permit application. CDPHE-APCD (2002) modeling guidelines specify the requirements for conducting modeling, including cumulative analyses; 4) all sources with the potential to emit any "criteria" air pollutant in excess of 50 tons per year must also provide the opportunity for the public to comment on the permit application; and 5) a Title V (or part 70) operating permit is required for all sources with the potential to emit air pollutants in excess of 100 tons per year. Since these pre-construction and operating permit programs are part of the Colorado State Implementation Plan, they have been approved (and are therefore enforceable) by EPA.

This NEPA analysis compares potential air quality impacts from the proposed action and alternatives to applicable ambient air quality standards, PSD increments, and AQRV impact threshold levels, but it does not represent a regulatory air quality permit analysis. Comparisons to the PSD Class I and II increments are intended to evaluate a "threshold of concern" for potentially significant adverse impacts, but do <u>not</u> represent a regulatory PSD Increment Consumption Analysis.

3.17.3 Environmental Consequences

No significant, adverse impacts to climate are anticipated from implementation of the proposed action or alternatives. Potential impacts to air quality were analyzed as described below.

3.17.3.1 Impact Types and Criteria

Potential air quality impacts from CBM development (proposed action and alternatives) were analyzed and reported solely under the requirements of NEPA, in order to assess and disclose reasonably foreseeable impacts to both the public and federal decision makers before a formal ROD is issued. Due to the preliminary nature of this NEPA analysis, it should be considered a "reasonable, but conservative" upper estimate of predicted impacts. Actual impacts at the time of development (subject to air pollutant emission source permitting by CDPHE-APCD) are likely to be less. An extensive Air Quality Impact Assessment Technical Support Document (RTP Environmental 2004) was prepared detailing the analysis procedures, and is available for review.

The air quality impact assessment was based on the best available engineering data and assumptions, meteorology data, and EPA dispersion modeling procedures, as well as professional engineering and scientific judgment. However, where specific data or procedures were not available, "reasonable, but conservative" assumptions were incorporated. For example, the air quality impact assessment assumed that all proposed Project Area CBM wells would go into production without any decline in production (no dry holes), then operate at full produc-

tion levels (no "shut ins") throughout the 20 year life of project (LOP). Therefore, this NEPA analysis assumes a development scenario which is not likely to actually occur.

The air pollutant dispersion modeling was based on one-year of on-site meteorological data collected near Bayfield, Colorado, as well as regional data generated by the MM4 and CALMET models, including hourly regional surface observations and twice-daily upper air soundings throughout calendar year 1990 (BLM 2000d).

The EPA Industrial Source Complex – Short Term (ISCST; version 95250) atmospheric dispersion model was used to predict maximum potential near-field ambient air pollutant concentrations (in the vicinity of assumed compressor and small well-head engine emission sources) for comparison with applicable air quality standards and PSD Class II increments, as well as potential hazardous air pollutant (HAP) impacts. In addition, the EPA California Puff (CALPUFF; version 5.0) atmospheric dispersion model was used to determine maximum far-field ambient air pollutant concentrations, atmospheric deposition (acid rain) and visibility impacts at Mesa Verde National Park and the Weminuche Wilderness Area.

The criteria for determining the significance of potential air quality impacts include state, tribal and federally enforced legal requirements to ensure air pollutant concentrations will remain within specific allowable levels. These requirements include the Colorado ambient air quality standards and the NAAQS which set maximum limits for several air pollutant concentrations, and PSD increments which limit the incremental increase of specific air pollutants (including NO_2, PM_{10}, and SO_2) above legally defined baseline concentration levels. These legal limits are presented in Table 3–188 and Table 3–189 above. Where legal limits have not been established, the best available scientific information is used to identify thresholds of potential significant adverse impacts. Thresholds have been identified for HAP incremental cancer risk, potential atmospheric deposition impacts to sensitive lake water chemistry and terrestrial ecosystems, and a "just noticeable change" in potential visibility impacts.

When reviewing the predicted near- and far-field (proposed action and alternative) impacts, it is important to understand the "reasonable, but conservative" assumptions made regarding potential resource development. In developing this analysis, there is uncertainty regarding ultimate development (i.e., number of wells, equipment to be used, specific locations, etc.) The analysis was also based on a reasonably foreseeable development scenario, some of which are conservative assumptions:

- Maximum measured background criteria air pollutant concentrations were assumed to occur at all locations in the region throughout the LOP. In addition, the maximum predicted air quality impacts would occur only in the vicinity of the anticipated emission sources. Actual impacts would be less beyond the predicted points of maximum impact.
- All proposed action and alternative emission sources were assumed to operate at their reasonably foreseeable maximum potential emission rates simultaneously throughout the LOP. Given the number of sources in-

cluded in this analysis, the co-probability of such a scenario actually occurring over an entire year (or even 24-hours) is small. While this assumption is typically used in modeling analyses, the resulting predicted impacts will be overstated.

- Maximum predicted operational air quality impacts are based on maximum projected development which would occur towards the end of the LOP. Since actual development would be phased in gradually, actual operational air quality impacts would also begin low, increasing throughout the LOP.
- All proposed Project Area CBM wells were assumed to be fully operational (no dry holes), at their maximum production rates, and remain operating (no "shut ins") throughout the LOP. This includes between 6,390 and 25,250 HP cumulative total gas-fired small well-head engines. In reality, well development equipment would be added or removed incrementally, as actual development requirements change.
- Maximum direct NO_2 impacts during operations were predicted based on assumed emissions from natural gas-fired separators, dehydrator heaters, and central compressors operating at a reasonably foreseeable NO_x emissions rate of 1.5 grams per horsepower-hour (g/HP-hour), as well as small well-head engines operating at an assumed NO_x emissions rate of nearly 10 g/HP-hour. These assumptions reflect emission levels for recently permitted equipment. Higher emission rates (representing engines using historic proven technology) would cause greater impacts. Engines with lower emission rates (using emerging state-of-the-art technology) would cause lower impacts, but given the limited history of their actual use, it would be difficult to guarantee their performance throughout the LOP. The ultimate operational emission rate will depend on the specific control measures required by the applicable air quality regulatory agency (including the CDPHE-APCD and EPA). The ultimate authority for CAA emission control enforcement rests with these regulatory agencies.
- All proposed central compression engines (between 14,240 and 46,000 HP cumulative total) were assumed to operate at their maximum rated capacities continuously throughout the LOP (no phased increases or reductions). In reality, compression equipment would be added or removed incrementally as required by well field operations, compression engines would operate below full horsepower ratings, and it is unlikely all compressor stations would operate at maximum levels simultaneously.
- Total predicted short-term air pollutant impact concentrations were assumed to be the sum of the highest measured background concentration, plus the maximum cumulative modeled concentrations, which actually occur under very different meteorological conditions and are not likely to coincide.
- Preliminary PM_{10} and SO_2 modeling analyses were performed for potential construction impacts in order to identify and apply the physical geometry for estimating the maximum potential impacts. However, actual orientation of future construction activities is not known.

Given those "reasonable, but conservative" analysis assumptions described above, which may actually compound one another, the predicted impacts represent an upper estimate of potential air quality impacts which are unlikely to actually be reached. It is important to note that before actual development could occur, the applicable air quality regulatory agencies (including CDPHE-APCD and EPA) would review specific air pollutant emissions preconstruction permit applications, which examine potential project-wide air quality impacts. As part of these permits (depending on source size), the air quality regulatory agencies could require additional air quality impacts analyses or mitigation measures. Thus, before development occurs, additional site-specific air quality analyses based on actual facility engineering data would be performed to ensure protection of air quality.

3.17.3.2 Impacts Common to All Alternatives

Air quality impacts would occur during construction (due to surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, and drilling rig and vehicle engine exhaust) and production (including natural gas separation and dehydration heaters, compressor and small well-head engine exhaust). The maximum predicted "near-field" air pollutant concentrations occur close to and between well locations; so close to each other that adding additional wells in other field locations would not increase the maximum predicted "near-field" concentration.

Air pollutant dispersion modeling was performed to quantify potential "reasonable, but conservative" PM_{10} and SO_2 impacts during construction based on the individual pollutant's period of maximum potential emissions, assuming four well pads could be constructed concurrently within a single square mile. Construction emissions would occur during resource road and well pad construction (3 days), well drilling (8 days), and well completion testing (25 days). During well completion testing, natural gas would be burned (flared) for up to 7 days. Since the burned natural gas is "sweet" (does not contain sulfur compounds), no objectionable odors are likely to occur. In addition, since orientation of the road and well pad is unknown, several preliminary PM_{10} and SO_2 modeling analyses were performed to identify and apply the physical geometry representing the maximum potential impacts (BLM 2000d).

Maximum potential near-field particulate matter emissions from traffic on unpaved roads and during well pad construction were used to predict the maximum 24-hour and annual average PM_{10} concentrations. Maximum air pollutant emissions from each well would be temporary (i.e., occurring during a 36-day construction period). The amount of air pollutant emissions during construction would be controlled by watering or applying chemical surfactants to disturbed soils, and by air pollutant emission limits imposed by applicable air quality regulatory agencies. The control efficiency of dust suppressants was computed at 50 percent during construction (equivalent to 1 to 2 percent surface material moisture content per EPA guidance). Actual air quality impacts depend on the amount, duration, location and emission characteristics of potential emissions sources, as well as meteorological conditions (wind speed and direction, precipitation, relative humidity, etc.)

The maximum potential 24-hour PM_{10} concentrations at least 650 feet (200 meters) from road and one-half mile (805 meters) from well emission sources (including a representative background value of 50 μg/m^3) would be nearly 127 μg/m^3, well below the applicable NAAQS of 150 μg/m^3. In addition, predicted particulate matter concentrations would decrease rapidly away from the emission source. Since these PM_{10} construction emissions are temporary, PSD increments are not applicable.

The maximum short-term SO_2 emissions would be generated by drilling rigs and other diesel engines used during rig-up, drilling, and completion operations (sulfur is a trace element in diesel fuel). These SO_2 emissions would be temporary, occurring only during the limited 36-day construction period at each well location. The maximum modeled concentrations, including representative background values of 57 μg/m^3 (3-hour) and 23 μg/m^3 (24-hour), would be nearly 702 μg/m^3 (3-hour) and 132 μg/m^3 (24-hour). Therefore, predicted short-term SO_2 concentrations are slightly above the restrictive Colorado SO_2 Ambient Air Quality Standard of 700 μg/m^3 (3-hour) but well below 365 μg/m^3 (24-hour). The 3-hour SO_2 NAAQS (1,300 μg/m^3) is less stringent. Given the conservative assumptions used in this modeling analysis, significant impacts are unlikely to occur, even when compared to the more restrictive Colorado 3-hour standard. Since these SO_2 construction emissions are temporary, PSD increments are not applicable.

Maximum HAP (formaldehyde) impacts were predicted for all potential natural gas-fired compressor and small well-head engines. Since neither the CDPHE-APCD nor EPA have established formaldehyde standards, the maximum predicted formaldehyde concentrations were used to estimate potential incremental cancer risks compared to an acceptable range of 1 to 100 occurrences within one million cases. The maximum formaldehyde concentration was predicted to occur at 320 meters (less then ¼ mile) adjacent to the largest compressor station; as the distance from the emission source increases, the predicted concentrations and incremental risk decrease rapidly. Since the capacity of this largest compressor station would not change significantly among Alternatives, the predicted increased cancer risk is consistent for all Alternatives. In addition, EPA (2004) recently proposed Maximum Achievable Control Technology (MACT) regulations for reciprocating internal combustion engines, which could be required on the assumed gas-fired compression engines, further reducing the predicted formaldehyde concentrations and associated risks.

Long-term (70-year) exposures from suspected carcinogenic emissions (formaldehyde) were used to estimate the incremental cancer risk at the maximum predicted concentration location. These were calculated from EPA (2003) unit risk factors for carcinogenic constituents. Two estimates of cancer risk were made; one that corresponds to a most likely exposure (MLE) condition, and one reflective of the maximally exposed individual (MEI). The estimated incremental cancer risks were adjusted to account for duration of exposure (20-year LOP) and time spent at home. Under the MLE scenario, the estimated incremental cancer risk associated with long-term exposure to formaldehyde (near the largest compression engine) would be 4.7 x 10^{-6}. Under the MEI analysis, the maximum individual cancer risk for formaldehyde would be 14.7 x 10^{-6}. Therefore, the predicted incremental cancer risks for the inhalation pathway all fall at the lower end

of the 1 to 100 x 10^{-6} threshold range. Given the conservative nature of these analyses, the predicted exposures are likely to overstate actual exposures, and the potential incremental cancer risks would not be significant.

3.17.3.3 Alternative 1 — Proposed Action

Significant air quality impacts would not occur under Alternative 1. No violations of applicable state, tribal, or federal air quality regulations or standards are expected to occur as a result of direct or indirect CBM development-related air pollutant emissions (including construction and operation).

Air pollutant dispersion modeling was performed to quantify potential "reasonable, but conservative" CO and NO_2 impacts during operation, based on the period of maximum potential emissions. Operation emissions would occur due to natural gas-fired separator and dehydrator heaters and pipeline compressor and small well-head engines. It is anticipated additional field-wide compression would be approximately 41,000 HP (at 14 compressor stations), plus nearly 14,350 HP from 141 small well-head engines. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2 or reactive VOC emissions would occur.

The maximum direct CO impacts during operation were predicted to be nearly 991 $\mu g/m^3$ (1-hour) and 389 $\mu g/m^3$ (8-hour). These values are below the EPA modeling guideline significance levels of 2,000 $\mu g/m^3$ (1-hour) and 500 $\mu g/m^3$ (8-hour). When these values are added to the assumed background concentration of nearly 2,300 $\mu g/m^3$, they would be less than 3,300 $\mu g/m^3$ (1-hour) and 2,700 $\mu g/m^3$ (8-hour), demonstrating compliance with the applicable NAAQS of 40,000 $\mu g/m^3$ (1-hour) and 10,000 $\mu g/m^3$ (8-hour), respectively.

The maximum potential near-field NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with standard EPA methodology (40 CFR 51, Appendix W, Section 6.2.3). The maximum predicted direct annual NO_2 impact was 24.8 $\mu g/m^3$, which is nearly equal to the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration (9 $\mu g/m^3$), the resulting predicted maximum total impact of 39 $\mu g/m^3$ is also well below the applicable NAAQS of 100 $\mu g/m^3$.

As stated previously, all NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis.

Potential direct atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas were also calculated. The maximum direct total (wet and dry) nitrogen deposition within these areas during operation were predicted to be nearly 0.009 kilograms per hectare-year (kg/ha-year) and 0.007 kg/ha-yr, respectively; well below the 3 kg/ha-year threshold (Fox et al. 1989). In addition, potential changes in Acid Neutralizing Capacity (ANC) at four lakes within the Weminuche Wilderness Area were all predicted to less than 0.8 percent (calculated for Upper Grizzly Lake), well below the 10 percent threshold for sensitive lakes (FS 2000).

Potential direct visibility impacts were calculated based on observed hourly relative humidity, as well as speciated aerosol concentrations measured between 1988 and 2004 at both Mesa Verde National Park and the Weminuche Wilderness Area. If the air quality impacts predicted under Alternative 1 had occurred during the observed visibility measurement period, a 1.0 deciview "just noticeable change" would not have been exceeded at Mesa Verde National Park on any day, and would have been exceeded between 0 and 3 days per year at the Weminuche Wilderness Area. However, given the "reasonable, but conservative" assumptions incorporated into this analysis, these direct impacts are not likely to occur.

3.17.3.4 Alternative 2

Significant air quality impacts would not occur under Alternative 2. No violations of applicable state, tribal, or federal air quality regulations or standards are expected to occur as a result of direct or indirect CBM development-related air pollutant emissions (including construction and operation).

Air pollutant dispersion modeling was performed to quantify potential "reasonable, but conservative" CO and NO_2 impacts during operation, based on the period of maximum potential emissions. Operation emissions would occur due to natural gas-fired separator and dehydrator heaters, pipeline compressors, and small well-head engines. It is anticipated additional field-wide compression would be approximately 46,000 HP (at 17 compressor stations), plus nearly 25,250 HP from 274 small well-head engines. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2 or reactive VOC emissions would occur.

The maximum direct CO impacts during operation were predicted to be nearly 1,218 $\mu g/m^3$ (1-hour) and 431 $\mu g/m^3$ (8-hour). These values are below the EPA modeling guideline significance levels of 2,000 $\mu g/m^3$ (1-hour) and 500 $\mu g/m^3$ (8-hour). When these values are added to the assumed background concentration of nearly 2,300 $\mu g/m^3$, they would be less than 3,600 $\mu g/m^3$ (1-hour) and 2,800 $\mu g/m^3$ (8-hour), demonstrating compliance with the applicable NAAQS of 40,000 $\mu g/m^3$ (1-hour) and 10,000 $\mu g/m^3$ (8-hour), respectively.

The maximum potential near-field NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with standard EPA methodology (40 CFR 51, Appendix W, Section 6.2.3). The maximum predicted direct annual NO_2 impact was 24.8 $\mu g/m^3$, which is nearly equal to the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration (9 $\mu g/m^3$), the resulting predicted maximum total impact of 38 $\mu g/m^3$ is also well below the applicable NAAQS of 100 $\mu g/m^3$.

As stated previously, all NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis.

Potential direct atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas were

also calculated. The maximum direct total (wet and dry) nitrogen deposition within these areas during operation were predicted to be nearly 0.013 kg/ha-year and 0.054 kg/ha-yr, respectively; well below the 3 kg/ha-year threshold (Fox et al. 1989). In addition, potential changes in ANC at four lakes within the Weminuche Wilderness Area were all predicted to less than 1.2 percent (calculated for Upper Grizzly Lake), well below the 10 percent threshold for sensitive lakes (FS 2000).

Potential direct visibility impacts were calculated based on observed hourly relative humidity, as well as speciated aerosol concentrations measured between 1988 and 2004 at both Mesa Verde National Park and the Weminuche Wilderness Area. If the air quality impacts predicted under Alternative 2 had occurred during the observed visibility measurement period, a 1.0 deciview "just noticeable change" would not have been exceeded at Mesa Verde National Park on any day, and would have been exceeded between 0 and 2 days per year at the Weminuche Wilderness Area. However, given the "reasonable, but conservative" assumptions incorporated into this analysis, these direct impacts are not likely to occur.

3.17.3.5 Alternative 5 — No Action

Significant air quality impacts would not occur under Alternative 5 — No Action. No violations of applicable state, tribal, or federal air quality regulations or standards are expected to occur as a result of direct or indirect CBM development-related air pollutant emissions (including construction and operation).

Air pollutant dispersion modeling was performed to quantify potential "reasonable, but conservative" CO and NO_2 impacts during operation, based on the period of maximum potential emissions. Operation emissions would occur due to natural gas-fired separator and dehydrator heaters and pipeline compressor and small well-head engines. It is anticipated additional field-wide compression would be approximately 14,240 HP (at 6 compressor stations), plus nearly 6,390 HP from 59 small well-head engines. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2 or reactive VOC emissions would occur.

The maximum direct CO impacts during operation were predicted to be nearly 646 $\mu g/m^3$ (1-hour) and 382 $\mu g/m^3$ (8-hour). These values are below the EPA modeling guideline significance levels of 2,000 $\mu g/m^3$ (1-hour) and 500 $\mu g/m^3$ (8-hour). When these values are added to the assumed background concentration of nearly 2,300 $\mu g/m^3$, they would be less than 3,000 $\mu g/m^3$ (1-hour) and 2,700 $\mu g/m^3$ (8-hour), demonstrating compliance with the applicable NAAQS of 40,000 $\mu g/m^3$ (1-hour) and 10,000 $\mu g/m^3$ (8-hour), respectively.

The maximum potential near-field NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with standard EPA methodology (40 CFR 51, Appendix W, Section 6.2.3). The maximum predicted direct annual NO_2 impact was 23.6 $\mu g/m^3$, which is nearly 94 percent of the applicable annual PSD Class II increment of 25 $\mu g/m^3$. When this value is added to the assumed representative background concentration

(9 μg/m^3), the resulting predicted maximum total impact of nearly 37 μg/m^3 is also well below the applicable NAAQS of 100 μg/m^3.

As stated previously, all NEPA analysis comparisons to the PSD Class II increments are intended to evaluate a threshold of concern, and do not represent a regulatory PSD Increment Consumption Analysis.

Potential direct atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas were also calculated. The maximum direct total (wet and dry) nitrogen deposition within these areas during operation were predicted to be nearly 0.002 kg/ha-yr and 0.006 kg/ha-year, respectively; well below the 3 kg/ha-year threshold (Fox et al. 1989). In addition, potential changes in ANC at four lakes within the Weminuche Wilderness Area were all predicted to less than 0.3 percent (calculated for Upper Grizzly Lake), well below the 10 percent threshold for sensitive lakes (FS 2000).

Potential direct visibility impacts were calculated based on observed hourly relative humidity, as well as speciated aerosol concentrations measured between 1988 and 2004 at both Mesa Verde National Park and the Weminuche Wilderness Area. If the air quality impacts predicted under Alternative 5 — No Action had occurred during the observed visibility measurement period, a 1.0 deciview "just noticeable change" would not have been exceeded at either Mesa Verde National Park or the Weminuche Wilderness Area on any day.

3.17.3.6 Alternative 6

Significant air quality impacts would not occur under Alternative 6. Given the lower number of potential well pad locations, overall air quality impacts would be somewhat less than those described in Section 3.17.3.3 Alternative 1 — Companies Proposed Action above, although the maximum predicted air quality impacts associated with CBM operations would be very similar.

3.17.3.7 Alternative 7

Significant air quality impacts would not occur under Alternative 7. Given the lower number of potential well pad locations, overall air quality impacts would be somewhat less than those described in Section 3.17.3.3 Alternative 1 — Companies Proposed Action above, although the maximum predicted air quality impacts associated with CBM operations would be very similar and slightly higher than Alternative 6.

3.17.3.8 Cumulative Effects

Air pollutant dispersion modeling was performed to quantify potential CO and NO_2 impacts during operation, based on the period of maximum potential emissions and other emission sources located within the Analysis Area (including tribal, Colorado, and New Mexico reasonably foreseeable sources). Operation emissions would occur due to natural gas-fired separator and dehydrator heaters, small well-head engines, and increased pipeline compression requirements. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2 or reactive VOC emissions would occur.

In addition, since the maximum direct modeled CO impacts (nearly 1,218 μg/m³ (1-hour) and 431 μg/m³ (8-hour) for Alternative 2 - Maximum Development) were below the EPA modeling guideline significance levels of 2,000 μg/m³ (1-hour) and 500 μg/m³ (8-hour), cumulative CO impacts were assumed not to be significant. Based on this analysis, it is assumed the cumulative effect of CO impacts from the proposed action and alternatives (plus other existing and reasonable foreseeable sources, and representative background concentrations) would not exceed applicable air quality standards.

Potential maximum annual cumulative NO_2 concentrations, under Alternatives 1, 2, and 5, were predicted to be 93.0 μg/m³, 93.2 μg/m³, and 92.8 μg/m³, respectively; close to, but not exceeding the annual NO_2 NAAQS of 100 μg/m³. Since the reasonably foreseeable NO_x emissions are dominated by existing and reasonably foreseeable sources (the proposed action and alternative sources account for nearly one percent of the total impact), the predicted maximum cumulative NO_2 concentrations are nearly the same among all Alternatives.

Potential maximum cumulative NO_2 concentrations, atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas are presented in Table 3–190. Most of the predicted impacts are below significance thresholds. The NPS and the FS consider potential visibility impacts within their mandatory federal PSD Class I areas greater than a 1.0 deciview "just noticeable change" from cumulative air pollutant emission sources to be an adverse impact. Given the "reasonable, but conservative" assumptions incorporated into the visibility impact analysis, the cumulative impacts are likely to be less than those presented in Table 3–190, although the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 0 to 10 days per year at Mesa Verde National Park, and between 1 to 18 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas.

Table 3–190 Maximum Potential Cumulative Air Quality Impacts by Management Alternative (including reasonably foreseeable Colorado, New Mexico and SUIT emission sources without Farmington RMP sources)

PSD Class I Area	Pollutant	Units	Alternative 1	Alternative 2	Alternative 5	Impact Threshold
Mesa Verde	Nitrogen Dioxide	Annual (μg/m³)	0.25	0.26	0.24	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.10	0.10	0.09	3
	Visibility	Greater than 1.0 deciview (days/year)	2 to 10	3 to 10	0 to 9	More than 1 day/year
Weminuche	Nitrogen Dioxide	Annual (μg/m³)	0.18	0.24	0.12	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.07	0.11	0.07	3
	Upper Grizzly Lake Chemistry[1]	ANC Change (percent)	3.4	3.9	2.9	10
		ANC Change (μeq/L)	0.8	0.9	0.7	1.0
	Visibility	Greater than 1.0 deciview (days/year)	1 to 13	5 to 18	1 to 9	More than 1 day/year

Note:
1. Potential cumulative impacts at other sensitive lakes would be less.
Source: RTP Environmental 2004

In addition to the cumulative air pollutant emission sources described above (including the proposed action and alternative sources, as well as other reasonably foreseeable emission sources located in Colorado, New Mexico, and on SUIT lands), the BLM recently initiated the process by which future natural gas development could occur under the jurisdiction of the Farmington, New Mexico, Field Office (BLM 2003a). Although the ROD (BLM 2003b) does not approve development of any additional individual wells (future NEPA analyses will be required prior to approving specific development), a "reasonable, but conservative" assessment of the possible air quality impacts from potential additional development in New Mexico was performed under this EIS.

The Farmington Proposed RMP included nearly 5,000 natural gas-fired well-head engines (operating at a 9.6 g/HP-hour NO_x emission rate) and 360,000 HP of additional natural gas-fired pipeline compression (operating at a 1.5 g/HP-hour NO_x emission rate). These potential emission sources were analyzed based on the following modeling assumptions:

- maximum projected development which could occur at the end of the LOP.
- wells would be fully operational (no dry holes), operate continually at maximum production rates, and remain operating (no "shut ins") throughout the LOP.
- gas-fired well-head engines would operate continually at their maximum design throughout the LOP.

In reality, well development equipment would be phased in gradually, and added or removed incrementally as actual development requirements change. These assumptions are made because the Farmington RMP does not authorize specific natural gas development; the assumptions reflect a "reasonable, but conservative" upper bound on potential air pollutant emissions and their predicted air quality impacts.

The maximum predicted cumulative NO_2 concentrations, atmospheric deposition and visibility impacts (including the Farmington RMP and Alternative 1, 2, and 5 emission sources) are presented in Table 3–191. Although most of the predicted impacts are below significance thresholds, because the background ANC level at Upper Grizzly Lake is less than 25 microequivlents per liter (μeq/L), the FS 1.0 μeq/L "Limit of Acceptable Change" is applicable. Therefore, based on "reasonable, but conservative" analysis assumptions, this threshold would be exceeded by the predicted impacts of 1.9 to 2.1 μeq/L. In addition, the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 34 to 62 days per year at the Mesa Verde National Park, and between 15 to 47 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas.

Further analysis was conducted to evaluate the potential effectiveness of more effective emission controls on Farmington RMP natural gas-fired well-head engines operating at a 2.0 g/HP-hour NO_x emission rate. Although control equipment is available at this emission rate, the costs of such controls are higher and their performance throughout a 20 year LOP has not been evaluated. Potential maximum cumulative NO_2 concentrations, atmospheric deposition, and visibility

impacts (including the Alternative 1, 2, and 5 emission sources) are presented in Table 3–192. Although most of the predicted impacts are below significance thresholds, because the background ANC level at Upper Grizzly Lake is less than 25 µeq/L, the FS 1.0 µeq/L "Limit of Acceptable Change" is applicable. Therefore, based on "reasonable, but conservative" analysis assumptions, this threshold would be exceeded by the predicted impacts of 1.1 to 1.4 µeq/L. In addition, the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 9 to 35 days per year at Mesa Verde National Park, and between 7 to 31 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas. Finally, small well-head engines with NO_x emission controls less than 2.0 g/HP-hour on both NSJB and Farmington RMP sources would not be adequate alone to assure cumulative visibility impacts would be less than the NPS and FS visibility "Limit of Acceptable Change."

Table 3–191 Maximum Potential Cumulative Air Quality Impacts by Management Alternative (including reasonably foreseeable Colorado, New Mexico, SUIT, and Farmington RMP emission sources with well-head engines operating at a 9.6 g/HP-hour NO_x emission rate)

PSD Class I Area	Pollutant	Units	Alternative 1	Alternative 2	Alternative 5	Impact Threshold
Mesa Verde	Nitrogen Dioxide	Annual (µg/m³)	0.51	0.57	0.49	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.22	0.22	0.21	3
	Visibility	Greater than 1.0 deciview (days/year)	36 to 61	36 to 62	34 to 59	More than 1 day/year
Weminuche	Nitrogen Dioxide	Annual (µg/m³)	0.27	0.33	0.21	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.14	0.18	0.14	3
	Upper Grizzly Lake Chemistry[1]	ANC Change (percent)	8.1	8.6	7.6	10
		ANC Change (µeq/L)	2.0	2.1	1.9	1.0
	Visibility	Greater than 1.0 deciview (days/year)	22 to 43	24 to 47	15 to 38	More than 1 day/year

Note:
1. Potential cumulative impacts at other sensitive lakes would be less.
Source: RTP Environmental 2004

3.17.4 Mitigation and Monitoring

3.17.4.1 Mitigation

Roads and well locations constructed on soils susceptible to wind erosion could be appropriately surfaced to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (surfacing materials, non-saline dust suppressants, water, etc.) could be used as necessary on unpaved collector, local and resource roads which present fugitive dust problems. To further reduce fugitive dust, Operators could establish and enforce speed limits (15 to 30 miles per hour) on all project-required roads in and adjacent to the Project Area. In addition, some Operators have begun using flare-less flow-back units to capture otherwise released gas instead of flaring the gas.

Table 3–192 Maximum Potential Cumulative Air Quality Impacts by Management Alternative (including reasonably foreseeable Colorado, New Mexico, SUIT, and Farmington RMP emission sources with well-head engines operating at a 2.0 g/HP-hour NO_x emission rate)

PSD Class I Area	Pollutant	Units	Alternative 1	Alternative 2	Alternative 5	Impact Threshold
Mesa Verde	Nitrogen Dioxide	Annual (μg/m[3])	0.37	0.52	0.36	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.15	0.16	0.15	3
	Visibility	Greater than 1.0 deciview (days/year)	10 to 31	10 to 35	9 to 28	More than 1 day/year
Weminuche	Nitrogen Dioxide	Annual (μg/m[3])	0.22	0.28	0.16	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.10	0.14	0.10	3
	Upper Grizzly Lake Chemistry[1]	ANC Change (percent)	5.1	5.5	4.6	10
		ANC Change (μeq/L)	1.2	1.3	1.1	1.0
	Visibility	Greater than 1.0 deciview (days/year)	7 to 24	11 to 31	7 to 20	More than 1 day/year

Note:
1. Potential cumulative impacts at other sensitive lakes would be less.
Source: RTP Environmental 2004

In developing the emission inventory for the air quality impact assessment, it was assumed that central compression engines would have a reasonably foreseeable average NO_x emission rate of 1.5 g/HP-hour during operation, which reflects recently permitted equipment using Lean-burn or Nonselective Catalytic Reduction technologies. As indicted in Table 3–193, a variety of potential emission reduction measures (BLM 1999) are available to limit NO_x and other pollutant emissions. This table is not intended to rank or identify a required emission reduction measure; the appropriate level of control would be determined and required by the applicable air quality regulatory agencies during their preconstruction permit application review process. In addition, where construction and operation of central compressor stations require a land use authorization from federal land managers, specific emission control limits may be considered for inclusion in the authorization.

While conducting the cumulative air quality impact assessment (RTP Environmental 2004), including potential emission sources identified in the Farmington Proposed RMP and Final EIS (BLM 2003a), it was determined that potential significant adverse impacts could occur under all alternatives if small (<300 HP) well-head engines were approved for operation at a NO_x emission rate of nearly 10 g/HP-hr. Under Alternative 2 (Maximum Development), these impacts were predicted to be 36 to 62 days at Mesa Verde National Park and 24 to 47 days at the Weminuche Wilderness Area above a "just noticeable change" per year. However, if small well-head engines were approved for operation at a NO_x emission rate of only 2.0 g/HP-hr, these Maximum Development potential impacts would be significantly reduced to 10 to 35 days at Mesa Verde National Park and 11 to 31 days at the Weminuche Wilderness Area. If the Farmington RMP small well-head engines were assumed to operate at the lower NO_x emission rate of 2.0 g/HP-hr, these potential impacts are further reduced to 10 to 31 days at Mesa Verde National Park and 7 to 24 days at the Weminuche Wilderness Area.

Table 3–193 Potential Central Compressor Engine NO_x Emission Control Measures

Control Measure	Percent Control	Emission Rate (g/HP-hr)	New/Retrofit	Comment
Lean-burn Combustion	80 to 90	1.5 to 4.0	Yes/Yes	Increase the air-to-fuel ratio to lower the peak combustion temperature, thus reducing the formation of NO_x.
Nonselective Catalytic Reduction	80 to 90	1.0 to 5.0	Yes/Limited	Installation of catalysts in the engine exhaust with sufficient VOC content (rich-burn engines).
Selective Catalytic Reduction	80 to 90	1.0 to 2.5	Yes/Limited	Installation of catalysts in the engine exhaust with significant oxygen content (lean-burn engines).
Electric Compression	100	0.0	Yes/No	Using electric compression motors could eliminate direct emissions, but increased NO_x emissions would occur at generation stations (such as from coal-fired power plants) often burning dirtier fuels.
Fuel Cell Technology	100	0.0	Not Available	Theoretical use of fuel cells would eliminate direct emissions, but size and number of necessary fuel cells are not currently available.

The Federal Land Managers are considering a range of small well-head engine mitigation strategies to reduce the magnitude and extent of these predicted significant adverse air quality impacts. The following mitigation strategies are within the jurisdiction of the Federal Land Managers' authority (based on their land-use authorization authority under applicable legislation):

- Specify a fixed NO_x Emission Rate for Small Well-head Engines. The Federal Land Managers would establish a specific emission rate limit on authorized equipment to minimize or prevent the predicted significant adverse cumulative air quality impacts from occurring. However, Operators could obtain site-specific approval to exceed the required emission rates if they demonstrate doing so would not cause or contribute to the predicted air quality impacts. This approach could be initiated 30 to 45 days after the FEIS is published, based on the existing Air Quality Impact Assessment (RTP Environmental 2004). This approach also provides certainty to industry, although significant adverse impacts would still happen from emission source growth not subject to Federal Land Managers' land use authorizations (i.e.; new power plants, additional private oil and gas development, population growth, etc.) In addition, the equipment necessary to achieve these emission rates may be more expensive than the higher emitting equipment used today.
- Establish a Total NO_x Emission "Level of Concern" for Small Well-head Engines. The Federal Land Managers would establish a cumulative total annual NO_x emission rate "limit of concern" for all authorized equipment to minimize or prevent the predicted significant adverse cumulative air quality impacts from occurring. If the "limit of concern" was reached, re-evaluation would occur, providing timely management review and ensur-

ing compliance with the Federal Land Managers' mandate to protect AQRVs through the applicable air quality regulatory agencies preconstruction permitting. Operators would choose their own individual equipment emission rates, as long as the cumulative total did not exceed a specified "level of concern." It would take at least six months to develop the necessary Letters of Agreement with CDPHE-APCD and the New Mexico Environment Division – Air Quality Bureau (NMED-AQB) to implement this approach after the FEIS is published, based on the existing Air Quality Impact Assessment (RTP Environmental 2004). This approach provides flexibility to industry, although significant adverse impacts would still happen from emission source growth not subject to Federal Land Managers' land use authorizations (i.e.; new power plants, additional private oil and gas development, population growth, etc.) Although industry has indicated in the past that they prefer this approach, it would require developing and implementing an extensive inventory, analysis and tracking system by the Federal Land Managers. In addition, companies which develop later in the process would be under more pressure to have lower emission rates than those who develop earlier in the process.

- <u>Establish an Adaptive Management Plan and Workgroup</u>. Modeled after the 1994 Northwest Forest Plan ROD (Espy and Babbitt 1994), the SJB would be designated an "Adaptive Management Area" where "the development and testing of technical and social approaches to achieving desired ecological, economic and other social objectives" (including air quality) is encouraged. It would probably take at least one year to initiate this approach after the FEIS is published, with the existing Air Quality Impact Assessment Technical Support Document (RTP Environmental 2004) as a starting point. This approach provides flexibility to state air quality regulatory and federal land management agencies, but ultimate requirements would be uncertain to industry. Since the process would adapt continually, significant adverse impacts would be prevented even if additional emission source growth happens which was not addressed in the FEIS (i.e.; new power plants, additional private oil and gas development, population growth, etc.) However, an Adaptive Management approach has not been applied previously to address anticipated air quality issues. Presumably, an interagency team would be assembled to develop a process for continual evaluation of alternative air pollutant emission rates (including, perhaps, the reduction of current emissions as off-sets to additional future emissions), in order to preclude the predicted significant adverse cumulative air quality impacts from occurring.
- <u>Establish an Air Quality Interagency Work Group</u>. Modeled after the NMED-AQD Ozone Task Force, the applicable air quality regulatory agencies (NMED-AQB and CDPHE-APCD) have established a "stakeholders" based organization (the Four Corners Task Force on Air Quality and Visibility) to further analyze and establish procedures for future regional industrial development (including, but broader than natural gas development alone) in order to prevent the predicted significant adverse cumulative air quality impacts from occurring. The Task Force has begun its efforts using the existing Air Quality Impact Assessment Technical Support Document (RTP Environmental 2004) as a starting point. It

is anticipated the Task Force will take two years to design, conduct, and implement its program. This approach provides flexibility to state air quality regulatory and federal land management agencies, but ultimate requirements would be uncertain to industry. Since the process could address a broader area than the existing air quality impact analysis, significant adverse impacts would be prevented even if emission source growth happens which was not addressed in the FEIS (i.e.; a larger analysis region, new power plants and central compressor stations, additional private oil and gas development, population growth, etc.).

- No Additional NO_x Emission Controls for Small Well-head Engines. EPA has established existing requirements to prevent significant adverse AQRV (including visibility and atmospheric deposition) impacts from occurring. This includes development of an extensive Regional Haze Program to assure achieving the National Visibility Goal for "… the prevention of any future and the remedying of any existing impairment of visibility in mandatory class I Federal areas." EPA's oversight of local, state, and tribal air quality regulatory agency implementation of these programs should prevent the predicted significant adverse impacts from actually occurring.

The Federal Land Managers discussed these alternative mitigation strategies with state (CDPHE-APCD and NMED-AQB) and federal (EPA Regions 8 and 6) air quality management agencies, and propose to implement a combination of measures. However, the selection of a specific mitigation strategy would not take place until the NEPA analysis and disclosure process is completed, and a formal Record of Decision is issued. The Federal Land Managers encouraged public, organization and agency comments through the DEIS on the following proposed mitigation measures to limit the predicted significant adverse impacts from occurring in Mesa Verde National Park and the Weminuche Wilderness federal mandatory PSD Class I areas:

- A formal Interagency Task Force was established by the NMED-AQB to expand both the analysis area (to include a larger portion of the Four Corners Region) and topics (such as emission source growth beyond oil and gas development alone, potential ozone impacts, PSD increment issues, expanded coal-fired power plant development, etc.) The Task Force includes participation by: CDPHE-APCD; tribal governments; the Federal Land Managers; EPA Regions 6, 8 and 9; environmental organizations; industry; and other stakeholder groups, funded jointly by the participants. Enforcement authority continues to rest with the applicable air quality regulatory agencies.
- Since it could take several months after the Task Force was established to identify specific mitigation measures, the Federal Land Managers would establish a fixed NO_x emission rate for small well-head engines to be effective as individual well authorizations are approved. Although the specific emission rate would not be determined until a Record of Decision is issued, the Federal Land Managers are currently considering a mandatory NO_x emission limit of 2.0 g/HP-hr for all new and replacement small well-head engines subject to their approval. The emission limit would remain in effect until the Task Force determines that alternative mitigation measures are necessary. Therefore, if the Task Force is

unable to develop specific measures, the interim requirement would apply throughout the LOP. Enforcement authority would rest with the applicable Federal Land Management agencies.

The following "mitigation measures" are outside the jurisdiction of the Federal Land Mangers' authority:

- Suspend Future Development Until Air Quality Issues Are Resolved. Previous NEPA document comments have suggested "reconsider future development after more information is gathered." Federal Land Managers can deny an individual "Application for Permit to Drill" only under very specific legal conditions. However, the applicable air quality regulatory agencies could review potential air pollutant emission sources and issue any applicable emission permits prior to construction and operation. Without this regulatory approval, the natural gas leases can not be developed.
- Withdraw or Prohibit Future Leasing. Previous NEPA document comments have suggested "withdraw or don't offer leases," apparently to eliminate natural gas development and the related air pollutant emissions. However, once a valid mineral lease has been issued, it may be conditioned, but not revoked. Similarly, under current federal mineral law, future leasing can be prohibited only in specific legal circumstances. The U.S. Congress could revise these laws, but the prospect of securing passage of such legislation and appropriation of funds for that specific purpose is extremely remote. In addition, elimination of natural gas leasing is inconsistent with Congressional direction (through the CAA) for development and promotion of alternative clean fuels needed to improve air quality nationally.
- NO_x Emissions "Cap and Trade". Previous NEPA document comments have suggested "consider NO_x emissions trading," therefore limiting NO_x emissions at current levels. Existing NO_x emission facilities could then either keep, trade or sell their emission allocations (essentially a property right to pollute) to other groups seeking to increase their NO_x emissions. When coupled with "banking" (holding, but not using credits) and "discounting" (reduced emission credit values with each "trade"), overall NO_x emissions would decrease. Under the CAA, the U.S. Congress has established an "allowance program" for certain SO_2 emitting facilities, and Congress could establish a similar NO_x trading program to be implemented by the applicable air quality regulatory agencies.
- Phased (Staged) Development. Previous NEPA document comments have suggested "reduce the intensity of natural gas development," such as limiting the "... number of wells or ... amount of emissions until reach[ing] 0.5 deciview..." The Federal Land Managers do not have the authority to require that development of existing leases be limited when specified emissions levels are reached. However, as described above, an overall air pollutant emissions "level of concern" could be established at a point where re-evaluation would occur, providing timely management review and ensuring compliance with the Federal Land Managers' mandate to protect AQRVs through participation in the applicable air quality regulatory agencies preconstruction permitting process.

3.17.4.2 Monitoring

The Federal Land Managers could continue to cooperate with existing atmospheric deposition and visibility impact monitoring programs. The need for, and the design of, additional monitoring could include the involvement of the EPA Region 8 Federal Leadership Forum (EPA 2001) and applicable air quality regulatory agencies. Based upon future recommendations, operators could be required to cooperate in the implementation of a coordinated air quality monitoring program. Oil and gas lease terms (Section 6) require the lessee, within the lease rights granted, to take measures deemed necessary by the lessor for the conduct of operations in a manner that minimizes adverse impacts to air quality, as well as other resources.

If additional mitigation processes and measures are required in the ROD, the Federal Land Managers must ensure that implementing these measures is monitored and enforced. For example, if operators are required to ensure small wellhead engines emit less than a specific NO_x emission rate, the Federal Land Managers must verify the face-plate engine power rating (taking into account average engine use, such as engine speed or hours of operation) as well as the manufacturers' guaranteed life-of-operations emission rating. In addition, if the Federal Land Managers have reason to believe required mitigation measures are not being met, then additional monitoring (such as combustion stack testing) and/or enforcement action (such as stopping operations) may be necessary.

Additional air quality monitoring may also be necessary. For example, in the Air Quality Impact Assessment Technical Support Document (RTP Environmental 2004), potential cumulative visibility impacts at Mesa Verde National Park and the Weminuche Wilderness Area were based on the FLAG Refined Daily impact analysis methodology. However, daily background visibility conditions were derived from IMPROVE speciated particulate matter sampling at each of these areas. An underestimate of background visibility could lead to an overestimate of potential visibility impacts from proposed NO_x emission sources. Therefore, direct optical monitoring in Mesa Verde National Park and/or Weminuche Wilderness Area (using a transmissometer or nephelometer) may be required to establish background conditions and future trends, regardless of impacting chemical/physical constituents. The Federal Land Managers may require that additional air quality monitoring be funded by the Operators.

3.17.5 Conformance to Existing Plans and Policies

Both the federal CAA and FLPMA require all federal activities (whether conducted directly, or approved through use authorizations) to comply with all applicable local, state, tribal and federal air quality law, statutes, regulations, standards and implementation plans. Potential CBM development under the proposed action and alternatives would conform to these requirements, consistent with existing land use plans.

3.17.6 Unavoidable Adverse Effects

Some decrease in air quality would occur through implementation of the proposed action or alternatives; however, based on the "reasonable, but conservative" modeling assumptions, these direct impacts are predicted to be below applicable significance thresholds.

3.17.7 Irreversible and Irretrievable Effects

Once disturbed lands are re-vegetated, potential air quality impacts from CBM development would cease after the life of the project. Therefore, there would be no irreversible or irretrievable effects on air quality.

3.18 Cultural Resources

3.18.1 Issues

Cultural resource sites include the physical locations and material remains of past and present cultures, including properties of traditional religious and cultural importance (hereinafter called traditional cultural properties), and areas of traditional use. Cultural resource sites that are listed on or evaluated as eligible for listing on the National Register of Historic Places are considered historic properties. Paleontological resources are geological resources and are addressed in the section on geology in the Project Area. The principal issues regarding cultural resource sites, traditional cultural properties, and areas of traditional use in the Project Area are the potential direct, indirect, and cumulative effects of further CBM development.

The following are the issues concerning cultural resources extracted from the public comments. The exact comments can be reviewed in the Scoping Summary report available from BLM and FS at the Public Lands Center in Durango.

Issue 13: How will further CBM development affect cultural resources and Native Americans?

The following are specific facets of this issue:

- *How will further CBM development affect sites, historic properties, traditional cultural properties, and areas of traditional use?*
- *How will further CBM development contribute cumulatively to impacts to cultural resource sites?*
- *Will intensive surveys be conducted on all proposed facility sites, as well as Section 106 compliance reports?*

3.18.2 Affected Environment

3.18.2.1 Project Area and "Area of Potential Effects"

The Project Area contains approximately 125,000 acres and is located in the area east of Durango, Colorado; west of the Piedra River; along State Highway 160; bordered on the south by the Southern Ute Indian Reservation. The analysis area includes private, State, BLM, and FS public lands.

The "Area of Potential Effects" (APE) is considered to be the Project (analysis) Area and the "Chimney Rock Archaeological Area," a Special Interest Area designated by the FS (Figure 3–85). This area lies east of the Piedra River, outside of the Project Area. The APE contains approximately 148,800 acres. The APE was defined to encompass any cultural resource sites that could potentially be directly, indirectly and/or cumulatively affected by the proposed project.

3.18.2.2 Regional Characterization

The Project Area is in the northeastern portion of the geographic and cultural region known as the Four Corners, where the States of Colorado, New Mexico, Arizona, and Utah meet. It lies within the southeast Animas drainage unit and the

southwest Upper San Juan-Piedra drainage unit. Elevations in the Animas drainage unit range from 6,000 to 7,550 feet in much of the southern portion of the unit. The biotic communities that are present, in descending order of elevation from north to south, are: alpine tundra (small portion); spruce-fir forest and pine-Douglas-fir forest; Gambel oak, scrubland, and pinyon-juniper woodland; and sagebrush-saltbush. Much of the Upper San Juan-Piedra drainage unit is more than 7,550 feet in elevation. The most prevalent biotic community in the unit is the pine-Douglas-fir forest, with smaller amounts of spruce-fir forest and pinyon-juniper woodland. Sagebrush and saltbush occur along the lower river valleys (Lipe et al. 1999:20).

The principal tributaries of the Animas, Los Pinos, Piedra, and San Juan Rivers are perennial in these units, providing more reliable water sources than in some other parts of the region.

3.18.2.3 Overview of Prehistoric Periods (10,000 B.C. to A.D. 1300)

The following discussion of major prehistoric cultural periods is adapted from Lipe et al. (1999). The prehistoric cultural chronology for the region is classified into eight periods, beginning with Paleoindian and ending with Protohistoric (for example, Ute and Navajo), with some overlap or variation in the date ranges. Brief characterizations of the prehistoric cultural periods represented in the archaeological record of the APE are presented below in order to identify the kinds of sites that are known from each period and that may be anticipated in the general area of the project.

Paleoindian (12,000 to 5,500 B.C.): The earliest period is the *Paleoindian*, which extends from approximately 12,000 B.C. to 5,500 B.C. The culture of the period is characterized by small, highly mobile bands of hunter-gatherers who specialized in the hunting of terminal *Pleistocene* mega-fauna. The principal hunting weapon was a thrusting, or hand thrown spear tipped with distinctive, fluted lanceolate projectile points. Their sites are identified by the occurrence of such points in association with the remains of extinct camels, giant sloth, mammoth, bison, and other large mammals of the time (Irwin-Williams 1973, Irwin-Williams and Haynes 1970). The period is further subdivided into early and late phases.

Projectile points of the earliest phase include *Clovis* and *Folsom*. The later phase is distinguished by a variety of non-fluted, shouldered, and stemmed projectile point forms that possess morphological characteristics not found on later types. For most of the Forest, the period is represented by a type associated with the later phase: the *Plano* type (Duke et al. 1985, Matlock 1988, York 1991).

No component of the Paleoindian period has been formally reported in the APE. Few Paleoindian components have been identified in the Southern Colorado River Basin, with the majority of these components identified in the Dolores and Yellowjacket areas west of the analysis area. The scarcity of archaeological remains dating to this period would make even small finds that could be firmly identified as Paleoindian potentially very important.

Research issues involve the recognition and categorization of sites dating to the Paleoindian period and discerning the transition from Paleoindian to Archaic period sites.

Archaic (5,500 to 1,000 B.C): The subsequent period, the Archaic can be broadly defined as a continuation of the hunter/gatherer lifeway, with several important changes. Archaic populations exploited a greater range of plant and animal resources, brought on in part by the extinction of the large mammals hunted in the earlier period. The Archaic also witnessed the development of a new hunting technology and increased population levels. This broader subsistence base is reflected in the material remains of Archaic artifact assemblages which characteristically possess greater varieties of tool types, more formalized "tool kits', and by the presence of implements intended for the processing of plant foods (e.g., manos, grinding slabs, and bedrock mortars). The Archaic is further distinguished from the preceding period on the basis of changes in hunting technology. The fluted and non-fluted lanceolate projectile point types are largely replaced with a variety of triangular, barbed types.

Like the preceding period, the Archaic is subdivided into more than one phase. There are three generalized stages: Early, Middle, and Late. Of the three stages, the Early Archaic is the least known and most poorly represented in the archaeological record in the general region. Early Archaic materials are differentially represented across the Forest, with some areas such as Turkey Springs near Pagosa Springs, yielding a higher incidence of Early Archaic associated sites than others. Locations off Forest, such as Ridges Basin near Durango, Colorado have also yielded a comparatively high incidence of Early Archaic materials (Winter et al., 1986). Projectile points generally associated with the Early Archaic include Bajada, Sudden Side-Notched, and Rockerbase Side-Notched (Matlock 1988).

The Middle Archaic and the Late Archaic are represented to a much greater degree than the early stage. The material culture associated with the two stages suggests an influence from the southwest, especially from the Oshara Tradition.

Only 11 site components dating to the Archaic period have been identified in the APE. This long cultural period is somewhat better represented in areas of more extensive pinyon-juniper woodlands west of the APE, roughly the same drainage units where Paleoindian components have been identified. The identification of early lithic sites as Archaic rather than Paleoindian in the field is often based on "cruder" biface technology, higher proportions of locally available lithic raw materials, the presence of ground stone artifacts, and the lack of ceramics.

Architectural/structural features from the Archaic include basin-shaped, possible pit house structures. Living and storage features include unlined and stone-lined fire pits. Artifact types are represented by stemmed and side-notched projectile points of the Oshara Tradition (e.g., Jay, Bajada, San Jose, Armiho, and En Medio phases). Groundstone artifacts (e.g., manos) for the processing of vegetal materials begin to appear in the archaeological record from this time. Archaic lifeways are characterized by a hunting and gathering subsistence base dependent on the procurement of small game. In addition, the introduction of maize is seen at approximately 400 B.C. Habitation sites during this period are characterized by base camps and satellite sites. Research issues involve chronological control for

poorly dated sites, the recognition of nascent maize agriculture, and the transition to Basketmaker tradition sites.

Basketmaker II (1,000 B.C. to A.D. 500): Sites that can be ascribed to this period and that have intact features, discrete activity areas, or in situ buried levels are potentially important. In the classic Pecos classification, the Basketmaker nomenclature was applied to preceramic early agricultural period sites. Some of the Basketmaker II sites in the Animas unit, and perhaps more widely in the APE, are identified because they are associated with a complex of attributes considered characteristic of this period (Lipe et al. 1999:137). A number of Basketmaker II sites have been excavated in the general vicinity of the study area, including several near the Animas River, and two to the south in the lower Navajo Reservoir area of New Mexico.

Architectural/structural features identified as Basketmaker II include rockshelter sites and shallow circular pit houses with walls of cribbed logs and mud mortar. Living and storage features from this period include hearths and heating pits sometimes exhibiting deflector slabs. Large storage pits are also prevalent from this period and include jar-shaped, basin-shaped, or slab lined features. Artifact types include large corner-notched, expanding stem dart points, T-shaped drills, manos and basin- and trough-shaped metates (grinding slabs) and basketry exhibiting half-rod-bundle foundations and noninterlocking stitches. Little or no pottery is known from Basketmaker II sites. By the onset of the Basketmaker II period, maize agriculture is fairly well established. Site types include habitation structures, limited activity sites, and rock art sites. In addition, evidence of external connections and trade is seen in the archaeological record from this period. Research issues involve improved chronological control for sites dated to this period, cultural origins as they pertain to the development of Ancestral Puebloan identity, changing subsistence and settlement patterns, the complexity of social organization, and evidence for external connections and trade.

Basketmaker III (A.D. 500 to 750): or Late Basketmaker is much more strongly represented by known sites in this region than any of the earlier periods and is the most strongly represented period in the APE. Sites of this period can be difficult to recognize during surface inventory. An increase in the number of sites that represent the Basketmaker III period when compared with earlier periods could indicate a research bias that recognizes these sites more readily, a simple increase in population, or the peak of Ancestral Puebloan occupation in the APE. These sites are associated with new technologies for pottery manufacture, architecture, hunting, and agriculture, and probably are at least partially associated with immigration into the region (Lipe et al. 1999:193). The majority of sites in the APE identified as having a Basketmaker III component are listed as transitional to Pueblo I or also containing a Pueblo I component.

Architectural/structural features identified as Basketmaker III include circular to subrectangular pit houses possessing an antechamber or ventilator. No substantial surface structures (i.e., roomblocks) are associated with Basketmaker III sites. Living and storage features include interior hearths possessing deflector slabs, slab-lined storage bins, exterior storage cists, small domed storage structures, and exterior hearth features. Artifact types include corner-notched projectile points for use with bow and arrow and plain pottery wares — predominately brown

wares and some later distinctive gray wares (e.g., Sambrito, Chapin Gray, Chapin Black-on-white, Rosa Gray, and early red wares). During the Basketmaker III period, maize agriculture becomes entrenched. Site types include single- and multiple-residence habitation sites, possible farmsteads or field houses, open artifact scatters, and rock art sites. Small communities, or hamlets, are seen to aggregate and dissolve. Research issues involve the origins of Basketmaker III populations, immigrations, landscape use, and lifeway changes. Of particular importance is the peak of occupation for sites dating to this period.

Pueblo I (A.D. 750 to 900): Pueblo I is the most strongly represented prehistoric period of the known components in the general region, but is slightly less strongly represented than Basketmaker III in the APE.

Architectural/structural features identified as Pueblo I include surface structures, in particular pueblos with multiple roomblocks. Construction characteristics include stone walls, earth-and-stone walls, jacal (i.e., wattle-and-daube) walls, and complete masonry. Square to rectangular pit structures are also known from this time period and may represent early examples of kivas (ceremonial chambers). These may incorporate rounded corners, ventilators, wing walls, benches, and posts or rafter beams. Living and storage features include interior hearths with deflector slabs, sipapus (i.e., ritual floor openings), and slab-lined storage bins. Exterior storage pits, hearths, and trash middens are also common. Artifact types include corner-notched projectile points with large tangs and small (sometimes contracting) stems, manos and metates, and ceramics (predominantly plain gray wares, neckbanded gray wares, Piedra Black-on-white, and other decorated red wares). A shift in agricultural strategy is seen based on water control and irrigation. Diversity in settlement/site type is also characteristic of the period and includes villages/settlements, multiple-residence sites (i.e., large hamlets), one- to two-household residences (i.e., small hamlets), field houses, and artifact scatters with or without features. Public architecture also appears in the form of great (or community) kivas, and water control features (e.g., canals, cisterns, and check dams). Changes in community organization accompany the diversity of site type from the Pueblo I period as reflected by the diversity of settlement types and the appearance of public architecture. Research issues involve the development of standards for artifact classification, the evaluation of site types, settlement patterns and village formation, culture history, village aggregation, migration, and cultural genesis.

Pueblo II (A.D. 900 to 1150): In the general region, early Pueblo II settlement is characterized by dispersed clusters of small habitation sites. In the southeastern portions of the APE there is an increase in sites at higher elevations. Fewer Pueblo II sites than Pueblo I or Basketmaker III sites occur within the APE.

Architectural/structural features common to Pueblo II sites include circular earth-walled or masonry pit structures with ventilators, small roomblocks of pole-and-adobe construction, and great houses with multiple-story construction, massive masonry walls, and blocked-in kivas. Living and storage features are similar to those from the preceding period and include interior hearths with deflector slabs, sipapus, and slab-lined storage bins. Artifact types include small corner-notched arrow points with concave bases and narrow stems, manos, metates, metate bins, and a variety of ceramic wares. Ceramic types include Moccasin Gray, Mancos

Gray, Chapin Gray, Mancos Corrugated, Dolores Corrugated, Mesa Verde Corrugated, and trade wares from the lower San Juan, Kayenta, Cibola, and Lowry Ruin areas. Site types include one- to two-family homesteads. In addition, influence from the Chaco Canyon area is seen in sites from this period and includes a variety of agricultural practices, long-distance trade networks, and more elaborate public architecture in the form of great kivas, great houses, roads, and water and soil control features. Research issues involve immigrations from the west and south (New Mexico), Chacoan social, economic, or ceremonial influence, cultural tradition of the Chimney Rock Phase, and the role of warfare and violence.

Pueblo III period (A.D. 1150 to 1300): In general, the principal occupations of the popularly known cliff dwellings and large open sites of southwest Colorado, such as in Mesa Verde National Park, date to the Pueblo III period. Well-documented sites of this period are much more common west of the APE, particularly in the Monument-McElmo, Ute, and Mesa Verde/Mancos drainage units. Where sites of the early part of this period are fairly numerous, they exhibit a pattern of large focal or community center sites with conspicuous public architecture contrasting with small, widely dispersed habitation sites. It is difficult to evaluate whether comparable patterns occurred in the APE because components of this period are so scarce.

Architectural/structural features include kivas with masonry walls, extensive surface roomblocks, cliff dwellings, and D-shaped (often multi-walled) masonry structures. Pecked-face block masonry also appears. As with the Pueblo II period, living and storage features are similar to those first exhibited during the Pueblo I period. Artifact types include small unstemmed triangular, stemmed, and side-notched projectile points, metates and metate bins, and a variety of ceramic types including Dolores and Mesa Verde Corrugated, McElmo and Mesa Verde Black-on-white, Tsegi Orange Ware polychromes, and some red wares. A decline in maize agricultural production is seen to coincide with rapid population increases. Public architecture persists with the addition of plazas and tower complex sites. Settlements shift from mesa tops to canyons and move from eastern canyons to western canyons. Research issues involve regional population and population dynamics, sedentism versus mobility, social organization, aggregation, political hierarchy, trade and extraregional relationships, the role of warfare and violence, and relationships to contemporary (i.e., modern) Native American groups.

Late Prehistoric to Protohistoric (A.D. 1300 to 1600): Components identified in the APE as Protohistoric include the first appearance of historic materials, as well as earlier Numic (Ute) and Athapaskan (Navajo or Apache) components. Later Protohistoric habitation sites are often associated with ceramic styles and residential structures that continue in use into the historic period, but smaller and more transient sites may be associated with lithic technologies that overlap between the two periods. Peeled trees, used by Numic and other Native American groups for medicines and starvation food, are interpreted as Protohistoric and historic Native American because of the life span and preservation of these trees.

Architectural/structural features from this period include sweat lodges, wickiups (Ute), and forked pole hogans with polygonal floor areas (Navajo). Living and storage features include exterior midden areas, hearths, and storage pits. Artifact types include Desert Side-notched or Cottonwood Triangular arrow points, and

cruder ceramic types, such as Ute brown wares, Dinétah Gray, and Gobernador polychromes. The rise of Navajo pueblitos is seen at this time. Other site types include sweat lodges, artifact scatters with associated features, simple artifact scatters, and special use and bark procurement sites. Research issues involve the timing and entry of Ute populations into southwestern Colorado, changes brought by the introduction of the horse into Ute culture, and Athapaskan (Navajo or Diné and Apache) entry into and exit from southwestern Colorado.

3.18.2.4 Historic Overview (A.D. 1664 to Present)

Major historical patterns in the area are summarized to provide a background for evaluating historic sites.

Spanish Frontier (1664 to 1822): Spanish settlements of the northern frontier of New Mexico traded with Ute bands in the 17th and 18th centuries, and several Spanish expeditions entered the area. Probably the most widely known expeditions were those of Juan de Rivera in the 1760s and of Domínguez and Escalante in 1776. Later, principal trading routes west from Santa Fe crossed through northwest New Mexico along the San Juan River, and prospectors entered the area. In the late 1850s, government-sponsored expeditions, including Marcy in 1857 and 1858 and Macomb in 1859, crossed through the general area. As important as some of these early events may be to history, they were small and transient in the APE and are not likely to have left much in the way of cultural resources. Pre-1850 European materials found in the APE are more likely to be materials traded to Native Americans than items carried into the region by European explorers, traders, or trappers. Key events and patterns in the history of this region are summarized by Husband (1984).

Ute Conflicts and Reservations (1850 to 1890): By the mid 1800s, the APE was essentially Ute territory, although Navajo and Apache groups also used the region. Anglo miners and settlers made few inroads into southwest Colorado until after the Colorado gold rush of 1859. Conflicts quickly escalated, and initial attempts at defining a Ute reservation were made with the Evans Treaty of 1863. The Hunt Treaty of 1868 established a Ute reservation that encompassed most of western Colorado, including the APE. However, 5 years later, the Brunot Agreement withdrew about 4 million acres in the mineral-rich San Juan region from the reservation. Conflicts between the Ute and Anglo miners and settlers continued, culminating in the Thornburgh battle on Milk Creek and the "Meeker Massacre" near the White River Agency in the north of the reservation. The northern Ute were removed to Utah in 1881, and by 1889, all but the present small Southern Ute and Ute Mountain Ute reservations had been opened to settlement.

Mining and Railroads (1868 to Present): Prospecting and settlement began in earnest after the Ute Reservation and Ute agencies were established in 1868. Early history in southwest Colorado was dominated by the hard rock and coal-mining industries. Durango was established in 1880 in anticipation of the arrival of the Denver & Rio Grande Railroad, and large smelters were built there. Early mining camps in the APE are scarce in comparison to the mountains to the north.

Early Farming and Ranching (1868 to 1900): Ranching, initially established in this region to supply regional towns and mining camps. Cattlemen entered the

region as soon as it was opened for settlement, and by the late 1800s there were cattle operations in the HD Mountains and Florida Mesa (Husband 1984:71). The cattle industry, like the mining industry, depended on the railroads to reach eastern markets.

Commercial farming, like the cattle industry, first entered the region to supply regional towns and mining camps. Transportation problems, water management, the brief growing season, and strained relations with the Ute Indians hampered early farming efforts. Fruit orchards attained success by the early 1900s in Montezuma and La Plata Counties.

Northern San Juan Basin Irrigation (1876 to Present): By the mid-1880s, regional irrigation and water supply companies were being formed. Many small ditches were built off the Pine and Florida Rivers to grow hay and grains for livestock and for attempts at other marginal crops. With increasingly arid conditions in the 1920s water often did not last through the summers and many farms failed. The Pine River Project and the construction of the Vallecito Reservoir were authorized by Congress in 1937, but completion of the project was slowed by the war effort (Simonds 1994). Studies for the Florida Project and the Lemon Reservoir began a few years after the Vallecito Reservoir and the Florida Project suffered more prolonged delays. Construction of Lemon Reservoir was finally authorized in 1960 (Autobee 1995). These projects were not as extensive as irrigation projects to the west, such as the Mancos and the Montezuma, but were nevertheless important to the development and survival of the livestock industry. Some of the smaller irrigation ditches fed by these irrigation projects developed from earlier systems begun in the 1890s. Those that have remained in use have been modernized and maintained over the years and may not retain physical characteristics that would distinguish them as early historic ditches.

Logging and the Lumber Industry (1870 to 1933): The intensive development of mining and the growth of towns and railroads depended, to a large degree, on the availability of lumber (Husband 1984). Although large logging operations complete with railroads are present elsewhere in southwestern Colorado, within the APE logging was characterized by small-scale operations with portable sawmills and temporary camps.

Federal Programs and Management of Public Lands (1891 to 1946): By 1890, the federal government had expanded its policies for the administration of public lands to include the conservation of the country's natural resources, notably mineral, timber, and grassland assets. A concern over the unrestricted use of forested lands in the West and the degradation of timber stands and watersheds led to policies geared toward the long-term productivity of the nation's forest reserves. In 1891, the Federal Government enacted the Forest Reserve Act, which eventually led to the creation of the FS under the USDA in 1905. The creation of the White River and Battlement Mesa Forest Reserves in 1891 and 1892, respectively, well illustrated this trend. The subsequent establishment of the Gunnison, Cochetopa, San Juan, Montezuma, and Uncompahgre Forest Reserves in 1905 extended conservation as a federal land policy tool under Theodore Roosevelt to over four million acres of southwestern Colorado forests. The San Juan Forest Reserve, created by presidential proclamation on June 3, 1905, originally encom-

passed an area of 1,435,406 acres. This was increased to 2,203,918 acres by 1907 (York 1980:8).

Despite many conflicts between battling special interest groups in the west as to the proper use of public lands, the establishment of the United States Forest Service (FS), the Bureau of Reclamation (BOR), the Soil Conservation Service (later renamed the Natural Resource Conservation Service), the BLM, and the NPS helped to reconçile conflicting interests and promote the "highest possible use of the public domain" (O'Rourke 1980:146). The Taylor Grazing Act of 1934, for example, addressed the problem of overgrazing on unappropriated public lands by establishing grazing districts and a permitting process (Husband 1984:104). The management of these districts and the issuance of grazing permits were ultimately overseen by the BLM, created in 1946 through the reorganization of the Taylor Grazing Service and the General Land Office.

Federal involvement in the development and use of public lands in southwest Colorado increased during the Depression era with the establishment of the Works Progress Administration (WPA) and the Civilian Conservation Corps (CCC). By the late 1930s, the CCC was responsible for planting millions of trees, constructing tens of thousands of check dams and other erosion control features, and stocking Colorado lakes and streams with millions of fish. In addition, the CCC participated in several projects in Southwestern Colorado, including the construction of reservoirs and extensive irrigation systems. For example, the Pine River Project and the construction of the Vallecito Reservoir, authorized by Congress in 1937 and completed by 1941 by the BOR, were at least partially staffed with CCC or WPA workers—though, forest records do not specifically say so. The project provided flood control and distributed supplemental irrigation water to 54,000 acres of land, including 13,000 acres on the Southern Ute Reservation (Guilfoyle et al. n.d.: 784). In addition CCC and WPA workers likely contributed to the construction and maintenance of campgrounds, picnic structures, and other public use areas within the forest. By the time of its demise in 1942, the CCC had employed over 30,000 Coloradans on conservation projects throughout the state. By 1936, the WPA was Colorado's largest single employer with more than 43,000 workers on its payroll. WPA projects included building schools, recreation buildings, sewage disposal plants, and dams (Abbot et al. 1984:290–291). Congress ended the WPA in 1943.

3.18.2.5 Native American Traditional Cultural Properties and Areas of Traditional Use

The National Historic Preservation Act of 1966 and its implementing regulations (36 CFR 800) require consultation with federally recognized Indian tribes to identify traditional cultural properties and consider potential effects on such properties as a result of a federal undertaking. In addition, FLPMA, NEPA, the American Indian Religious Freedom Act (AIRFA), and E.O. No. 13007: "Indian Sacred Sites" contain requirements for consulting with tribes on the potential effects of federal undertakings. Traditional Properties are properties of religious or cultural importance. Areas of traditional use may include areas used to gather plants, animals, or fish for subsistence or for ceremonial or medicinal purposes. The National Register Bulletin No. 38 provides guidance for identification and evaluation of such properties.

The following tribes have been determined to have cultural ties or interests to the area encompassed by this analysis:

Southern Ute	Pueblo of Isleta	Pueblo of Sandia
Northern Ute	Pueblo of Jemez	Pueblo of Santa Ana
Ute Mountain Ute	Pueblo of Laguna	Pueblo of Santa Clara
Navajo	Pueblo of Nambe	Pueblo of Santo Domingo
Jicarilla Apache	Pueblo of Picuris	Pueblo of Taos
Hopi	Pueblo of Pojoaque	Pueblo of Tesuque
Zuni	Pueblo of San Felipe	Pueblo of Zia
Pueblo of Acoma	Pueblo of San Ildefonso	
Pueblo of Cochiti	Pueblo of San Juan	

Tribal consultations for the NSJB CBM analysis were initiated by letter in 2003. An initial contact letter was sent to the tribes listed above. This letter summarized the proposed action and the 5 alternatives; described the geographical location of the area; provided the current archaeological information based upon the class I inventory information that had been conducted at that point in the analysis; initiated consultation; and requested identification of places of traditional cultural importance, and/or other issues or concerns. A response was requested from the Tribes with an indication of their desire to participate in continuing consultations for the proposed project. The same Tribes were provided the DEIS. Responses were received from the Pueblo of Santa Clara, the Hopi Tribe, and the Southern Ute Tribe.

The Pueblo of Santa Clara indicated that their people had used the APE in the past for hunting, trading, and other reasons. They asked to be provided with copies of reports concerning the project when they became available and indicated that they may wish to schedule a meeting in the future to discuss protection of sacred and traditional areas identified in reports.

Responses from the Hopi and the Southern Ute Tribes indicated their desire to be active participants in the consultation process. Subsequent consultations have been carried out through letters, meetings, and phone calls.

The Hopi Tribe stated that they claim cultural affiliation to the prehistoric culture groups in this area. They expressed concern about inventory efforts being conducted at the site-specific level and the resulting limitations in conducting an accurate cumulative effects analysis at the landscape level. They indicated that they would like to see a landscape focus for the archaeological identification efforts. The Hopi consider that "Hopitutskwa" or "Hopi Land" is considered to be everywhere that Hopi people and their ancestors traveled, lived, and were buried in the long period of time in which migrations from the place of emergence, to their present location on the Hopi Mesa occurred. This cultural landscape is defined in part by "itaakuku" or "footprints" that were left behind. These remains include not only former settlements, but also artifacts, rock images, shrines, and trails that are considered by the Hopi to be to be inextricably associated with the region in which they occur. The Hopi expressed the desire to incorporate a Hopi ethno-

graphic study of the analysis area in order to provide more detailed information on the context of Hopi ancestral connections to the land and cultural resources.

In addition to indicating that they wished to be active participants in the consultation process for this project, the Southern Ute Indian Tribe wished to be notified of inadvertent discoveries of Native American sites, artifacts, or human remains. The Tribe also stated that they want to maintain the Eastern part of their Reservation as wilderness.

During the course of the analysis, all of the Tribes were invited to participate in the development of the programmatic agreement that would establish the Section 106 compliance process for coal-bed methane development under this EIS. The Pueblo of Laguna indicated that they did not wish to be involved in the programmatic agreement development, and that they had not identified any places of traditional cultural importance. No additional responses (from the Hopi and Southern Ute Tribes) were received. As work progressed on the cultural portion of the analysis, the concept of the development of a Cultural Resources Management Plan (CuRMP) as a mitigation measure for the project emerged as a more effective means of addressing the myriad of cultural considerations than a programmatic agreement. The Hopi Tribe and the Southern Ute Tribe will be afforded the opportunity to participate in the development of the CuRMP.

Public scoping and outreach efforts conducted as part of the analysis included other potential groups who may have traditional cultural associations with the APEs. No specific traditional cultural properties have been identified within the analysis area as a result of the consultations.

3.18.2.6 Summary of Known Cultural Resource Sites

A comprehensive Class I inventory was conducted for all lands within the APE. The data derived from this inventory form the basis of the effects analysis. Data sources used for the Class I inventory include:

- The Colorado Office of Archaeology and Historic Preservation (OAHP) files, Cultural Database, and GIS site and inventory spatial and attribute data.
- The San Juan Public Lands Office (BLM and FS) archaeological site and inventory records; cultural resource overlay maps, and GIS geodatabase.

An updated files search was conducted through the OAHP in January 2006 and June 2006. This data was combined with the current SJNF geodatabase data from January 2006 and June 2006, additional sites digitized from the SJNF map overlays, and digitized data provided by the San Juan Public Lands Office in February. Known site densities in surveyed areas range from one site per square mile up to 35 sites per square mile. Many sections with high site densities also contained numerous isolated finds. Isolated finds by definition are considered not eligible for the National Register of Historic Places. The files search for the APE contained 1,377 cultural resources, of which 709 are sites.

Approximately 261 previous cultural resource inventories have been conducted within the APE. Most of these inventories have been intensive cultural resource inventories for Section 106 compliance, but there have also been investigations

for state and local government and for research projects. Survey coverage has been extensive on FS land surrounding the HD Mountains and along the Highway 160 corridor. The overall average site density documented by previous Section 106 investigations within the APE is approximately 12 sites per square mile. Additional sites in the APE are known from early investigations prior to the cultural resource management process established by the National Historic Preservation Act. Approximately 34.6 percent of known sites (245) in the APE are listed on the National Register, contribute to the eligibility of a National Register District, or are recommended as eligible for the National Register, and are therefore considered historic properties. In addition, 25.2 percent of the known sites (179) are unevaluated and would require additional investigations to properly assess their eligibility. Some of these sites include those for which documentation is not currently available. Unevaluated sites are managed as historic properties until evaluation determinations are completed.

Prehistoric archaeological site types recorded in the APE include open architectural sites, open camps, rock shelters, rock art, artifact scatters, and lithic procurement sites. Sites may include multiple components (distinct cultural units that reflect multiple time periods) because they have been occupied more than once. These numbers exclude diagnostic isolated finds and components that were unclassified or were listed as unknown prehistoric. Of the 1,377 cultural resources documented in the APE, 668 were identified as isolated finds, 170 had the period or affiliation listed as unknown, and documentation was missing or incomplete for 84. Table 3–194 lists the number of cultural components identified to the archaeological periods described earlier or to a specific historic period (n = 660).

Table 3–194 Cultural Components by Time Period

Affiliation/Period[1]	Number	Portion (percent)
Paleoindian	0	0
Archaic	28	4
Basketmaker II	16	2
Basketmaker III	132	20
Pueblo I	186	28
Pueblo II	147	22
Pueblo III	8	2
Unspecified "Anasazi" or "Pueblo"	57	9
Late Prehistoric to Protohistoric	27	4
Specific Historic Period	59	9
Total	660	100

Note:
1. Number of cultural components is not comparable to total number of sites, as many sites have multiple cultural components.

The APE lies across two major drainage units as identified in the prehistoric archaeological context for the Southern Colorado River Basin, namely the Animas and Upper San Juan-Piedra drainage units (Lipe et al. 1999:5). Together, these two units contain approximately 11 percent (1,738 of 15,579 estimated) of the total sites recorded within the entire Southern Colorado River Basin archaeological context area — with the majority of the sites in these units dating from the Pueblo I to Pueblo II periods, representing the northeastern most extent of Ancestral Puebloan settlement (Lipe et al. 1999:406). Considering the overall number of sites recorded in southwest Colorado, this represents a relatively high site density. However, it has been noted that site density studies within the general context area may be biased due to the amount of actual survey coverage recorded for any given unit. That is, site densities within the context area represent a function of the amount of cultural resource surveys that have been conducted within a given drainage unit. Given the fact that only a small amount of systematic, intensive up-to-date cultural resource surveys have been conducted in the APE in comparison to the entire Southern Colorado River Basin context area, the potential for finding additional important archaeological sites within the APE is considered good. In particular, the APE has a high potential to provide information regarding PI to PII settlement shifts in the region in that the Upper San Juan-Piedra basin is one of only two drainage units to show significant population growth during the early PII period (Lipe et al. 1999:406).

No specific TCPs or areas of traditional use have been documented in the APE. No Areas of Critical Environmental Concern (ACEC) for cultural resource sites in the APE have been identified by the BLM. One Special Interest Area (SIA), the Chimney Rock Archaeological Area has been established by the FS. Two National Register Archaeological Districts exist within the APE.

The Spring Creek National Register District (5LP1254, also known as Zabel Canyon Indian Ruins) lies within the APE. Listed on the National Register of Historic Places in 1983, the Spring Creek Archaeological District includes 101 sites listed within its boundary in the Colorado OAHP cultural database. Twenty-five of the sites were listed as contributing to the theme of the district in the nomination form completed by SJNF archaeologists. Types of prehistoric sites within the district include pit structures, open architecture, roomblocks, open lithic (chipped and ground stone) scatters, and concentrations of ceramics (pottery sherds). These site types likely represent the remnants of small, aboriginal farming communities. The district shows a long occupancy from as early as 300 B.C., dated primarily through ceramic styles. Cultural periods are represented from the Archaic, Basketmaker II through Pueblo I periods, with some Pueblo II and Protohistoric components also noted.

Four areas of significance (research themes) were identified for the Spring Creek Archaeological District. First, the district contains general research value in that its sites may allow for the reconstruction of aboriginal lifeways. Secondly, cultural resources within the district also exhibit a high potential for supplying chronological control for sites within the Pine River watershed. Third, sites within the district have the potential to address prehistoric human use and settlement patterns that may elucidate paleo-human ecology. Lastly, the district possesses "tenuity value" in that at the time of its nomination to the NRHP it represented "the only lands left on the Pine River watershed that are relatively undis-

turbed by modern agricultural practices, inhabitation, or widespread archaeological site depredation." As such, the district presents an opportunity for unhampered, scholarly archaeological research.

The Chimney Rock Archaeological Area (CRAA) was created by the Rocky Mountain Regional Forester's Order of May 28, 1970 (36 CFR 251.22 authority) for the purposes of protecting and recreationally developing the unique prehistoric resources located within its boundaries. It is located east of and adjacent to the APE, and contains 3,160 acres of SJNF land bounded by the Southern Ute Indian Reservation. The central portion of the CRAA, encompassing approximately 960 of its acres, was also listed on the National Register of Historic Places as a National Register Archaeological District in 1970. In addition, the CRAA was added to the Chaco Archaeological Protection Site System in the Chaco Joint Management Plan as of September 1991 by an act of Congress.

The CRAA is the best-known late Pueblo II settlement cluster in the upper SJB. Hundreds of individual sites dot the landscape. The Chimney Rock phase is dated from about A.D. 1000 to 1125 and is exemplified by a large aggregation of habitation sites surrounding a Chacoan-style great house known as Chimney Rock Pueblo. The CRAA has been only partially surveyed, but there are at least 91 structures that may have been permanent, plus 27 work camps near farming areas, adding up to more than 200 individual rooms. The high mesa holds 16 individual sites, 14 of which are residential. Four of these sites, the Great Kiva, Pit House, Ridge House, and Great House Pueblo, have been excavated, stabilized, and interpreted for the public.

Historic site types, including farming and ranching resources, are also likely to be found in the APE. For example, known sites include sheep and cattle camps, historic aspen carvings (often associated with sheep and cattle herders), and the Pine-Piedra Stock Driveway. Resources such as these are likely to be more abundant and varied in the western portion of the APE. A few remains of logging towns, sawmills, skids, wagon roads, and railroad spurs also exist in the APE. In addition, stand-alone irrigation features, such as ditches, canals, and stock tanks, are also likely to be encountered within the APE.

The historic sites previously recorded in the APE include 24 houses or homesteads, 12 ranches or farms, 2 farm or ranch features, 11 urban or commercial buildings, 10 canals or ditches, 6 trash scatters, 4 railroad grade segments, and 10 sites of various other types.

Two extensive linear resources are present in the APE that may be affected by all the alternatives. These are the Old Spanish Trail (5LP4213) and the Pine-Piedra Stock Driveway (5AA528). The Old Spanish Trail has been designated as a National Historic Trail. A National Management Plan and Environmental Analysis for the Old Spanish Trail is currently under preparation by the National Park Service and the BLM. The currently mapped location of the Old Spanish Trail is based on historic maps, and the existence of visible remains of this trail has not been verified by field survey. Several access and pipeline corridors would use or cross portions of the Pine-Piedra Stock Driveway. Appropriate mitigation of impact to the historic character of this stock trail would be developed.

3.18.3 Environmental Consequences

Cultural resource sites can include historic or prehistoric artifact scatters, buildings or structures, landscape modifications, portable and non-portable art, buried features, or traditional cultural properties and places of traditional use. These manifestations of past human activity can be considered significant and eligible for listing in the National Register of Historic Places. Evaluation of significance is based on four criteria: (a) association with past historical or traditional events or pattern of events, (b) association with the contributions of an individual important in history or tradition, (c) representation of an artistic, structural, or engineering tradition, or (d) potential to yield information important in history or prehistory. All of these kinds of importance are associated to some extent with the location or context where they are found. For example, the physical setting of a site is a key component in its eligibility for the National Register of Historic Places. Development of CBM involves local areas of earth disturbance, including the drilling location itself, laydown and support areas, access roads, pipelines, and additional support facilities such as meter stations and water handling facilities. Any earth-disturbing activities can destroy or diminish not just the buildings, structures, and objects, but the setting and context that are part of their importance. Direct physical effects to resources from construction and operation of CBM facilities are immediate and irreversible. The preferred management strategy for cultural resource sites within the APE is to avoid and protect the sites from direct and indirect impacts.

Section 106 of the National Historic Preservation Act requires that federal agencies take into account the effects of a federal undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register. According to 36 CFR 800, the implementing regulations of the Act, "undertaking" means a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a federal agency, including (a) those carried out by or on behalf of the agency, (b) those carried out with federal financial assistance, (c) those requiring a federal permit license, or approval, and (d) those subject to state or local regulation administered pursuant to a delegation or approval by a federal agency. Section 106 compliance also applies to non-federal lands when federal funding, licensing, permitting, and approval are required; when federal minerals are involved; when access to federal minerals involves private land; or when the APE extends beyond project boundaries. Because the permission of the landowner is required to conduct Section 106 compliance work on private or state lands, the federal agency would work cooperatively with other landowners to fulfill Section 106 compliance responsibilities.

The cultural resource survey and technical report are the basic data-gathering procedure of Section 106 and NEPA compliance. Intensive inventory will be conducted in areas of ground disturbance within the APE where no previous intensive inventories have been completed. Section 106 compliance reports are required to document the results of cultural resource inventories and must be completed and consulted on prior to project implementation. The BLM is designated as the lead agency for this Project. As lead agency, the BLM will conduct Section 106 in accordance with established Colorado BLM processes. A CuRMP will be developed by the San Juan Public Lands (BLM/FS) in consultation with

the Colorado State Historic Preservation Officer (SHPO) and other parties as identified through consultation.

3.18.3.1 Effects to Cultural Resource Sites

Potential effects to historic properties from continued CBM development in the NSJB would include destruction and deterioration of prehistoric and historical objects, structures, buildings, sites, districts, and cultural landscapes that represent the patterns, traditions, and achievements of human societies in this region. These effects would result from development and operation of CBM facilities and from incidental or ancillary activities that are associated with development and operation.

Indirect effects to cultural resource sites are not always as obvious or immediate as direct effects, and can include effects that occur off-site from the areas of construction and operation. Indirect effects may include: accelerated erosion due to increased traffic, construction, loss or changes of vegetation, and changes in drainage patterns; inadvertent damage from increased visitation to sites not previously accessible and not "hardened" for public use; and increased vandalism. Development may also result in piecemeal or incremental loss or degradation of the various elements of integrity, (setting, feeling, location, etc.) that are integral to the cultural landscape within the APE and also to individual site significance within the APE, through CBM development.

Indirect physical effects to resources can also include deterioration of structures or rock art from vibration, dust, or exhaust produced by construction or operation. Erosion and changes to vegetation that result from off-site construction can also change the characteristics and integrity of a site. If the setting and feeling of a site are essential elements of its importance, visual or auditory intrusions or deterioration of the local environment would also constitute an indirect effect to the aesthetic quality of the site. An additional potential indirect effect results when development of CBM and access roads makes some areas more accessible to off-highway vehicles. This accessibility results in the potential for more people to visit a site and increases the chance for incidental deterioration or vandalism.

Historic properties are nonrenewable resources, and they lose integrity, heritage value, and potentially important information if they are destroyed or altered. Measures can be implemented to avoid the impacts for the majority of the properties under federal jurisdiction. Treatments to minimize or mitigate adverse effects to historic properties can include project relocation, redesign, or modification, physical protection measures such as fencing or padding, stabilization, restoration, rehabilitation, documentation, monitoring, repair, or data recovery. Any treatment of a historic property must be consistent with federal standards and other guidelines, policies, and direction.

Federal responsibilities for Section 106 compliance extend to federal actions in which access to private minerals involves federal land, or access to federal minerals involves ground disturbance on private or state land. Landowner permission is needed to allow Section 106 compliance work on state and private lands in these situations. The BLM and FS would work cooperatively with private landowners to determine the appropriate inventory and mitigation measures on pri-

vate surface. Landowner refusal to allow this work does not preclude the federal agency from approving the permit for the project. Current BLM policy is to document in the case file that the landowner denied access for cultural resource assessment, and then to complete the cultural analysis with the best available information. In all cases, the BLM and FS would work diligently and cooperatively with the landowners to fulfill the Section 106 compliance responsibilities.

Table 3–195 portrays the numbers of cultural resource sites and historic properties that may be located within areas of new disturbance by each Alternative and surface ownership. These numbers are derived from two sources: 1) Known sites were identified by overlaying the Alternatives on the GIS coverage for known sites in the APE; and 2) Projected sites were derived by overlaying the Alternatives on the GIS coverage for intensive cultural resource surveys; identifying the acreage that has not been surveyed; and multiplying that by the average number of sites per acre reported by past surveys.

For this GIS analysis, when laying approximate spatial data for project alternatives over locations of known sites, extensive cultural resource sites that appear within several proposed project elements (such as well pads, pipelines, access roads, and ancillary facilities) were counted as potentially impacted sites for each project element in which they were present. For example, project elements may cross large linear sites, such as railway grades or roads in more than one location. In cases like these, each individual site segment was counted as a separate potentially impacted site.

A total of 709 cultural resource sites have been identified in the APE from approximately 37,831 acres of survey. The number of sites per surveyed acre is 0.019. The number of known historic properties depicted in Table 3–195 includes listed, eligible, and unevaluated sites. The projected number of sites within the proposed disturbance was generated by multiplying the number of known sites per surveyed acre by the unsurveyed acres of proposed disturbance. The percentage of projected historic properties was generated using the ratio of eligible and listed sites (245 sites) to the total number of sites within the APE (709 sites), excluding the unevaluated sites (179), for a total of 530 sites; this ratio equals 46.2 percent (245/530 x 100 = 46.2). The projected number of historic properties was generated by multiplying the 46.2 percentage by the number of projected sites.

Two extensive linear resources are present in the APE that may be affected by all the alternatives. These are the Pine-Piedra Stock Driveway (5AA528) and the Old Spanish Trail (5LP4213). Several access and pipeline corridors would use or cross portions of the Pine-Piedra Stock Driveway. Appropriate mitigation of impact to the historic character of this stock trail would be developed. The currently mapped location of the Old Spanish Trail is based on historic maps, and the existence of visible remains of this trail has not been verified by field survey. If visible remains of this trail are identified within the APE of any federal actions, appropriate measures would be developed to avoid and mitigate adverse impacts.

Table 3–195 Known and Projected Sites and Historic Properties within Proposed Disturbance by Alternative

Alternative/ Surface Owner	Projected Acreage of Proposed Disturbance	Number of Known Sites within Proposed Disturbance	Number of Known Historic Properties within Proposed Disturbance	Number of Projected Sites within Proposed Disturbance	Number of Projected Historic Properties within Proposed Disturbance	Total Number of Historic Properties (Known and Projected) within Proposed Disturbance
1						
BLM	36	4	0	2	1	1
USFS	679	34	11	10	5	16
State	22	0	0	1	0	0
Private	264	21	11	33	15	26
Outside[1]	7	0	0	0	0	0
Undetermined[2]	82	0	0	2	1	1
Total	1090	59	22	48	22	44
2						
BLM	76	22	4	6	3	7
USFS	1,106	57	17	56	26	43
State	42	0	0	5	2	2
Private	565	36	16	88	41	57
Outside[1]	7	0	0	0	0	0
Undetermined[2]	82	0	0	2	1	1
Total	1,878	115	37	157	73	110
5						
BLM	0	3	0	2	1	1
USFS	84	9	2	1	0	2
State	21	0	0	1	0	0
Private	278	21	11	33	15	26
Outside[1]	3	0	0	0	0	0
Undetermined[2]	61	0	0	1	0	0
Total	447	33	13	38	16	33
6						
BLM	29	4	0	2	1	1
USFS	314	30	10	2	1	11
State	21	0	0	1	0	0
Private	245	21	11	33	15	26
Outside[1]	7	0	0	0	0	0
Undetermined[2]	82	0	0	2	1	1
Total	698	55	21	40	18	39
7						
BLM	31	4	0	2	1	1
USFS	515	32	11	5	2	13
State	23	0	0	1	0	0
Private	248	21	11	33	15	26
Outside[1]	7	0	0	0	0	0
Undetermined[2]	82	0	0	2	1	1
Total	906	57	22	43	19	41

Notes:
1. Outside = proposed disturbance outside of the Project Area boundary.
2. Undetermined = potential disturbance in unspecified locations.
*

All federal undertakings, which may include private lands and/or minerals in certain situations, are subject to Section 106 review under the implementing regula-

tions of the National Historic Preservation Act. The preferred treatment of historic properties for federal undertakings is avoidance and protection. For all of the following Alternatives, plans would be developed to avoid or mitigate impacts to all eligible sites.

Construction and operation of new facilities may also increase traffic in the APE and facilitate access for people who are not associated with the project. This increased access may result in cumulative deterioration of historic properties. However, mitigation measures would be implemented to restrict public use of the expanded road system by gating roads and restricting public use to selected routes only, except under Alternative 5 (no federal action). These routes are identified in the Recreation Section of this chapter.

3.18.3.1.1 Alternative 1 — Proposed Action

Under Alternative 1, fifty-nine known cultural resources are within areas of proposed disturbance. Twenty-two of these cultural resources are historic properties (11 FS, 11 private).

The analysis projects that 48 additional sites may be within areas of proposed disturbance under this alternative. The majority of those sites (33) are expected to be located on private surface. Twelve sites are projected for federal surface (2 BLM, 10 FS) and one site is projected for State surface. Of the projected sites, 22 are expected to be historic properties (1 BLM, 5 FS, 15 private, 1 undetermined). Therefore, a total of 44 known and projected historic properties may be within areas of proposed disturbance under this alternative.

3.18.3.1.2 Alternative 2

Under Alternative 2, one hundred fifteen known cultural resources are within areas of proposed disturbance. Thirty-seven of these cultural resources are historic properties (4 BLM, 17 FS, 16 private).

The analysis projects that 157 additional sites may be within areas of proposed disturbance under this alternative. Eighty-eight of these sites are expected to be located on private surface. Sixty-two sites are projected for federal surface (6 BLM, 56 FS) and five sites are projected for State surface. Of the projected sites, 73 are expected to be historic properties (3 BLM, 26 FS, 41 private, 2 state, 1 undetermined). Therefore, a total of 110 known and projected historic properties may be within areas of proposed disturbance under this alternative.

3.18.3.1.3 Alternative 5 — No Action

Under Alternative 5, thirty-three known cultural resources are within areas of proposed disturbance. Thirteen of these cultural resources are historic properties (2 FS, 11 private).

The analysis projects that 38 additional sites may be within areas of proposed disturbance under this alternative. The majority of those sites (33) are expected to be located on private surface. Of the projected sites, 16 are expected to be historic properties (1 BLM, 15 private). Therefore, a total of 33 known and projected historic properties may be within areas of proposed disturbance under this alternative.

3.18.3.1.4 Alternative 6

Under Alternative 6, fifty-five known cultural resources are within areas of proposed disturbance. Twenty-one of these cultural resources are historic properties (10 FS, 11 private).

The analysis projects that 40 additional sites may be within areas of proposed disturbance under this alternative. The majority of those sites (33) are expected to be located on private surface. Of the projected sites, 18 are expected to be historic properties (1 BLM, 1 FS, 15 private, 1 undetermined). Therefore, a total of 39 known and projected historic properties may be within areas of proposed disturbance under this alternative.

3.18.3.1.5 Alternative 7

Under Alternative 7, fifty-seven known cultural resources are within areas of proposed disturbance. Twenty-two of these cultural resources are historic properties (11 FS, 11 private).

The analysis projects that 43 additional sites may be within areas of proposed disturbance under this alternative. The majority of those sites (33) are expected to be located on private surface. Of the projected sites, 19 are expected to be historic properties (1 BLM, 2 FS, 15 private, 1 undetermined). Therefore, a total of 41 known and projected historic properties may be within areas of proposed disturbance under this alternative.

3.18.4 Cumulative Effects

Potential negative cumulative effects on cultural resource sites within the APE over the long term could result in degradation, or even loss of historic properties due to the incremental impact of past, present, and reasonably foreseeable future actions. This degradation and loss could include the physical existence of historic properties; and also degradation and loss of significant values whether they are scientific, cultural, or associative. Beneficial cumulative effects will be increased information and identification of cultural resources as a direct result of development within the project area. The majority of the cultural resource information populating federal and state databases has been generated through Section 106 undertakings. Our knowledge and understanding of the cultural resources within the project area will be greatly expanded as a result of this project.

Potential negative cumulative effects to cultural resource sites may include: accelerated erosion due to increased traffic, construction, loss of vegetation, and changes in drainage patterns; inadvertent damage from increased visitation to sites not previously accessible and not "hardened" for public use; and increased vandalism. Coal bed methane development may also result in piecemeal or incremental loss or degradation of the various elements of integrity, (setting, feeling, location, etc) that are integral to the cultural landscape within the APE and also to individual site significance within the APE. Visual and auditory intrusions may have indirect and cumulative effects to certain historic properties for which setting and feeling are important aspects of the site significance.

The sections above address each alternative and the projected number of cultural resource sites that may potentially be directly affected by the extent of proposed surface disturbance. All federal undertakings will be subject to Section 106 review. Based on the proportion of known sites that are listed on or considered eligible for the National Register, about 46 percent of the cultural resource sites that may be affected will be historic properties. The potential adverse effects to these properties cannot be derived from the database or existing records, but must be identified in the field; and mitigation developed that addresses the specific situation, and also that takes into consideration the long term cumulative effects.

The western portion of the APE is largely privately owned and has experienced over 100 years of development. These developments include farms, ranches, and residential and urban sprawl. The eastern portion of the APE in Archuleta County has experienced only a minor amount of development which has been mainly associated with ranching, grazing, limited logging and oil and gas exploration, and the CO Highway 160 corridor. Most of the development on private lands did not consider effects to cultural resources. Projects occurring on federal lands that occurred after the implementation of National Historic Preservation Act regulations were included in the Class I overview for this analysis.

La Plata County is experiencing rapid residential and commercial growth and development. The higher population levels associated with the expansion in the County and increased access into remote areas can result in increased vandalism. Development of lands for various reasons may contribute to the permanent and unintentional destruction of segments of the archaeological and historical record. As stated above, unless a project is a federal undertaking, effects to historic properties are usually not considered in private developments. However, some local authorities, such as counties, have recently begun to require impact assessments for historic properties as part of their permitting regulations. Although this may reduce impacts to historic properties, non-federal undertakings still have the potential to adversely affect historic properties directly, indirectly and cumulatively.

Other currently proposed large-scale projects in the APE with the potential to impact cultural resource sites, traditional cultural properties, and area of traditional use, include the U.S. Highway 160 from Durango to Bayfield Project, and the Sauls Creek Fuels Reduction Project. Section 106 consultation for the proposed U.S. Highway 160 from Durango to Bayfield Project has already been conducted. It has been determined that there will be no adverse effects as a result of this project. It is anticipated that the Sauls Creek Fuels Reduction Project will avoid all adverse effects to historic properties. Cumulative effects resulting from these projects are predicted to be minimal.

In coal bed methane development, avoidance and protection are the preferred management measures for historic properties, and it will be feasible to avoid and protect the majority of historic properties. Coal bed methane field development also would improve access to the vicinity of some historic properties, increase traffic and activities near cultural resource sites, and increase the potential for inadvertent effects from unrelated activities. The combination of past, present, and reasonably foreseeable fluid mineral leasing, future increases in gas well concentrations (down-spacing), and other recent and planned projects in the APE,

plus the increase in the number of visitors to the area, may incrementally increase the cumulative effects to historic properties.

3.18.5 Mitigation and Monitoring

All areas of proposed ground disturbance for federal actions will be intensively inventoried for cultural resources prior to approval. All cultural resource sites that are within surveyed areas or that could be affected by the proposed project must be evaluated for eligibility to the National Register of Historic Places. Evaluations will consider the integrity of setting, location, and feeling in regards to site significance. All undertakings which involve historic properties, including unevaluated sites, will be assessed for potential effect, including direct, indirect, and cumulative effects. The Advisory Council on Historic Preservation regulations implementing Section 106 of the National Historic Preservation Act (36 CFR 800) require a determination of effect for federal actions on historic properties. An "adverse effect" occurs when an impact alters, directly or indirectly, any characteristic of a historic property that qualifies it for the National Register. "Adverse effect" includes reasonably foreseeable effects caused by the preferred alternative that could occur, either immediately or later in time, that would be farther removed in distance, or that would be cumulative (36 CFR 800.5). A determination of "no adverse effect" means that there is an effect, but the effect would not diminish in any way the characteristics of the historic property that qualify it for the National Register. "No historic properties effected" means either there are no historic properties known to be located within the APE, or there are historic properties present, but the undertaking will have no effect upon them.

Avoidance and protection are the preferred management strategies for historic properties; however this may not be possible in all cases. Specific treatment plans to mitigate the adverse effects to historic properties will be identified and completed prior to project implementation. Treatment plans will be developed in consultation with the SHPO and other parties and, if applicable, the private surface owner.

At a minimum cultural resource survey and mitigation will follow BLM Cultural Resource Manual and policies, and Office of Archaeology and Historic Preservation standards. The following mitigation and monitoring measures, will address direct, indirect and cumulative effects. These mitigation and monitoring measures will be funded by the Operators unless otherwise stated.

Mitigation and monitoring measures and best management practices/stipulations include but are not limited to the following:

Mitigation and monitoring measures:

- Relocation, redesign, or constraint of project facilities and infrastructure to avoid disturbance to historic properties, including historic properties that may be adjacent to such facilities, in order to avoid or minimize direct, indirect, or cumulative effects. These measures may include barricading or fencing sensitive areas and buffer zones.

- Relocation, redesign, or constraints on project facilities and infrastructure to avoid or minimize visual intrusion on a sensitive historic property, traditional cultural property, or area of traditional use. This action might include low-profile facilities, non-intrusive colors, landscaping, berms, screening with vegetation, or other measures to minimize visual impact.
- Historic properties will be avoided by a 300-foot minimum buffer, unless otherwise specified by the Authorized Officer and/or other mitigating measures are developed. If a project is specified by the Authorized Officer to be within 100 feet of a historic property, all ground disturbing activity will be monitored by a permitted archaeologist.
- Stabilization of sediments, bedrock, or structures that could be destabilized or could deteriorate as a result of nearby development or traffic, that could cause impacts to historic properties; and identification of appropriate buffer zones.
- Restriction to or prevention of access to sensitive areas. Changing area access designations and limiting public access to roads and trails.
- Stabilization or protective screening of buildings, structures, or artwork to minimize deterioration.
- Data recovery of a historic property that cannot be avoided or protected in place. Data recovery is the systematic recovery of data important in history or prehistory for which the property is considered eligible. Data recovery for prehistoric or historic archaeological sites typically entails excavation of buried materials and detailed documentation of stratigraphic context. Data recovery also includes laboratory analysis of artifacts recovered, as well as appropriate analytical and chronometric tests; and compilation into a scientific report. Data reporting can also be done in alternate formats such as books, videos, or exhibits; in order to provide this information to the public and tribes.
- Detailed documentation and research as a preservation technique for buildings, structures, and art; including methods such as 3D laser scanning, Historic American Building Surveys (HABS), total station mapping, archival photo documentation, archival and contextual research for historic properties that cannot feasibly be avoided or protected in place.
- In some instances due to poor ground surface visibility, geomorphology, or high potential for subsurface deposits it may be necessary for a permitted archaeologist to monitor ground-disturbing activities. If unanticipated discoveries are made in connection with operations, the project proponent will immediately suspend all operations in the vicinity of the find and cannot resume until the discovery is appropriately treated and authorization is given by the federal agency.

Best Management Practices:

- Recommend that oil and gas operators use best management practices that include conducting large block inventories instead of a limited, disturbance-specific approach, to efficiently plan field development activities for large geographic areas over reasonably foreseeable time periods. Examples include Plans of Development (PODs) based on large area block survey information. Such PODs can either include or lay the

groundwork for proposals with multiple permit actions. This approach facilitates more time-saving, efficient, and effective approaches to compliance with Section 106 of the National Historic Preservation Act, which will result in permit process improvements (e.g., time and cost savings), and more effective management of cultural landscapes.

- An additional best management practice is maintenance of the cultural resource data base in order to more effectively and efficiently manage the cultural resources. When this data base is properly maintained it ultimately results in time and cost savings for the oil and gas operators and better management of the cultural resources as it facilitates accurate and up-to-date Class I literature reviews, better analysis of potential effects to the cultural landscape, and prevents unnecessary resurvey of previously surveyed areas. Operators will provide funding adequate to maintain data generated by projects related to this EIS.

- Intensive inventories may not identify all historic properties in an APE because natural conditions can hinder the identification process. Unanticipated discoveries are situations in which undocumented cultural resources or human remains are encountered during construction or operation of facilities. If unanticipated discoveries are made in connection with operations, the project proponent will immediately suspend all operations in the vicinity of the find and cannot resume until the discovery is appropriately treated and authorization is given by the federal agency.

- During intensive cultural resource inventories, archaeologists will include within the APE and document standing architectural sites, rock shelters, and rock art sites that are visible from proposed new disturbance projects. This will require archaeologists conducting cultural resource surveys to scan the vicinity of proposed projects with binoculars for such sites.

- Oil and gas operators will regularly inform their employees, contractors, and subcontracts as to the legal obligations to avoid damage to or destruction of cultural resources, and their obligations to halt operations and contact the agency immediately if cultural resources are inadvertently discovered. They will also inform their employees, contractors, and subcontractors of the laws and penalties regarding illegal collection of artifacts.

- If human remains are encountered on federal land, the federal agency must follow the Native American Graves Protection and Repatriation Act (25 U.S.C. 3001) and its implementing regulations. Pursuant to 43 CFR 10.4(g), the authorized officer must be notified, by telephone, with written confirmation, immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony. Furthermore, pursuant to 43CFR10.4 (c) and (d), activities must stop in the vicinity of the discovery and the discovery must be protected for 30 days or until notified to proceed by the authorized officer.

- If human remains are encountered on state or private lands, all work near the discovery will be stopped immediately in accordance with Colorado Revised Statutes (CRS) 24–80–1302 and local authorities (for example, county sheriff or coroner) will be contacted. The local authorities will

cooperate with the operator to determine whether the human remains are recent and of forensic concern, or whether they are historic or prehistoric in nature. If the human remains are determined to be historic or prehistoric, the County Coroner is required to contact the Colorado State Archaeologist, who is responsible for preparation of a treatment plan for the human remains. This treatment plan will include provisions to identify lineal descendants or culturally affiliated persons. Construction or operation of facilities will resume in the area of discovery only under the stipulations of the treatment plan or after the treatment plan has been satisfactorily carried out.

- If a pattern of unanticipated discoveries becomes evident, it may be necessary to require limited testing, (eg. shovel testing) during intensive cultural resource surveys.
- A complete intensive inventory of the Spring Creek National Register Archaeological District will be conducted to more thoroughly document the District, including clarification of District boundaries, and the associated update of the National Register listing, prior to the authorization of any new development in the area. This inventory is necessary to facilitate the long-term management and protection of these significant resources and to better address indirect and cumulative effects.
- Any new development within the exterior boundaries of the Spring Creek National Register Archaeological District will be limited or minimized to the extent necessary to protect those characteristics that are integral to the District's significance.
- Cultural resource site locations and surveyed area locations will be provided by the consulting archaeological firm to the Federal agencies in shape file format, projected in NAD83, along with the final report. Shapefile attribute data will include Smithsonian numbers for cultural resources and federal report numbers for survey areas. All site location information is proprietary.

Cultural Resource Management Plan:

- Within one year of signing the Record of Decision for the project, a Cultural Resource Management Plan (CuRMP) will be developed in consultation with the SHPO and other consulting parties. This management plan will provide the framework to address cumulative effects and provide strategies for pro-active management of cultural resources within the NSJB EIS APE which will be further refined through implementation of the CuRMP. No coal bed methane development permits beyond those which were processed during development of this EIS will be authorized until the CuRMP is completed. The CuRMP will develop additional inventory and evaluation standards, mitigating measures and monitoring that will be conditions of approval for all coal bed methane development permits in the project area, including those authorized by this EIS. The CuRMP will be reviewed every three years by the San Juan Public Lands and the Colorado SHPO, unless an alternate schedule is agreed upon by these parties. The CuRMP may include, but is not limited to the following:

- Research design criteria and context; criteria for site evaluation and survey requirements; site management classifications including priority heritage assets, BLM Use Categories, and properties at risk; a burial treatment plan; and development of a site settlement survey, which will include sample surveys of landforms that may have high potential for cultural resources.
- A monitoring plan to ensure that mitigating measures are successfully implemented and maintained; and that no direct, indirect, or cumulative effects are occurring to historic properties. Monitoring reports will be prepared every six months by permitted archaeologists which will be provided to the agency archaeologists, who will forward copies to the SHPO.
- Models of high site density areas to identify specific APEs that will require a minimum 40 acre block survey. The size of the block survey may be adjusted as necessary as new information becomes available.
- Develop criteria and specifications for GIS visual analyses to identify areas of potential visual effects.
- Develop appropriate ethnographic studies relevant to the APE in order to facilitate identification and evaluation of traditional cultural properties, and other places of traditional cultural importance through the development of appropriate cultural context. This is especially important as there may be a high likelihood that these types of cultural resource sites may not be recognized during archaeological surveys by archaeologists. It is encouraged to have Tribes actively participate in partnership with the BLM/FS and project proponents to develop, conduct, and administer such studies.

3.18.6 Conformance to Existing Plans and Policies

The 1984 RMP for the BLM San Juan and San Miguel Planning Areas emphasizes avoidance and protection of important cultural resource sites through proactive resource management. The RMP states all areas of potential effect would be inventoried for cultural resource sites, and treatment of those resources would comply with Section 106 of the National Historic Preservation Act. While the preferred management strategies are avoidance and protection, all alternatives would conform equally to the RMP.

The SJNF LRMP places a similar emphasis on avoidance and protection of all cultural resource sites. However, the FS includes mitigation measures or development for recreation and non-recreation use as options for the protection of sites. Sites listed on the National Register of Historic Places within the APE include the Spring Creek Archaeological District, and the Chimney Rock Archaeological Area. All areas of proposed disturbance would be inventoried for cultural resources, and treatment of these resources would comply with Section 106 of the National Historic Preservation Act. While the preferred management strategies are avoidance and protection, all alternatives would conform equally to the LRMP.

3.18.7 Unavoidable Adverse Effects

Because avoidance of historic properties is the preferred mitigation measure, the majority of undertakings will have no effect. Relocation of project elements can avoid damage to historic properties. Restriction of access to sensitive areas can reduce indirect effects to cultural resource sites, traditional cultural areas, and areas of traditional use, such as vandalism and erosion. However, some unavoidable indirect and cumulative effects may still occur. For example, noise from construction activities can impinge on areas of traditional use; and construction and operation of facilities can cause visual intrusions on traditional cultural properties and areas of traditional use.

Under the proposed action and other action alternatives, new surface disturbance will occur to varying degrees. As project implementation proceeds and well pad and infrastructure locations are proposed, site-specific information will be gathered through literature searches and intensive inventories to identify potential adverse effects to cultural resource sites. Mitigation and monitoring measures will be implemented to avoid adverse effects. However, such disturbance has the potential for unanticipated discoveries which could result in an adverse effect to a historic property. Therefore, there is the potential for unanticipated unavoidable adverse effects to cultural resource sites, traditional cultural properties, and areas of traditional use. As outlined above, a monitoring plan will be developed to ensure that mitigating measures are being successfully implemented, and to identify unforeseen indirect or cumulative effects to historic properties.

3.18.8 Irreversible and Irretrievable Effects

Compliance with Section 106 requirements for all undertakings associated with all alternatives would prevent or minimize irreversible or irretrievable effects to historic properties within the APE. However, an irreversible or irretrievable effect could potentially occur when resources are damaged or lost as a result of vandalism or through ground disturbance that inadvertently destroys unanticipated cultural resources. The potential for vandalism would be mitigated through restriction of access in the APE. Unanticipated discoveries would be mitigated as outlined above.

Data recovery as a mitigation measure or as a proactive research project also results in an irreversible and irretrievable effect. Once archaeological data are removed from their original in situ deposition, there is no way to replace them and their associated data. However, the information gained from such data recovery is usually considered substantial enough to outweigh the irreversible and irretrievable effect. Data recovery within the APE would only be conducted under an approved research design and treatment plan, developed through consultation with the SHPO and the appropriate Tribes.

3.19 Cumulative Effects

3.19.1 Cumulative Effects Analysis Area

The general cumulative effect analysis area for most resource analyses is the Project Area (125,000 acres) and that portion of the Southern Ute Indian Reservation that has and will continue to experience CBM development over the next decade (422,000 acres). The cumulative effects analysis area is therefore 547,000 acres, encompassing the Colorado portion of the SJB. The water, economic, and air quality cumulative effects analysis area, however, extends into New Mexico and includes foreseeable oil and gas development within the BLM Farmington Resource Area and Jicarilla Ranger District, Carson National Forest.

The cumulative effect analysis considers the environmental consequences of oil and gas development and other potential impacting activities. Other activities that have and may contribute to cumulative impacts include rural and urban housing development, timber harvest, fire management, livestock grazing, recreation, agriculture, and road construction. These factors of concern are discussed below.

3.19.2 Oil and Gas Development

Oil and gas development is projected to continue both within and south of the Project Area. The companies propose to drill 284 additional CBM wells over the next decade within the Project Area as described in Chapter 2. South of the Project Area, within the bounds of the Southern Ute Reservation, 636 additional gas wells, 70 injection wells for enhanced coal bed methane projects, and associated facilities are projected for Tribal minerals and 586 wells are projected for non-tribal minerals. Other reasonably foreseeable oil and gas development includes development in the New Mexico portion of the SJB (CBM, conventional gas, and oil). Within New Mexico, the FEIS for the Farmington Resource Area RMP projects development of 9,900 new wells over the next 20 years, drilled at a rate of about 500 wells per year. This level of regional development is important when assessing economic, water, and air quality impacts. The cumulative effects area for most other resources is more localized due to a lack of interaction of resources between the two regions defined by northern New Mexico and Southwest Colorado.

Within the Colorado portion of the SJB, there are approximately 2,500 wells in operation. Where the productive trends in different geologic formations overlap or where oil is produced in New Mexico, there are often more than a dozen wells in a single 640-acre section. In less prospective areas, there are only one or two producing wells in a section.

This level of development presented above when taken with existing development, presents concerns about degradation of wildlife habitat effectiveness, impacts to the area's visual quality, the potential for reduced property values, impacts to recreational settings and opportunities, noise conflicts, depletions of surface waters, and various health and safety issues, particularly at the Fruitland Formation outcrop.

3.19.3 Community Expansion

Community expansion has and will continue to contribute to cumulative impacts. Community Expansion in La Plata County is expected to include growth in the residential population, related increases in commercial operations and development of county roads, and small industrial developments unrelated to mineral resources. No major industrial project, such as a power plant or new factory, is foreseen in La Plata County. Instead, community growth is expected to be based on influx of individuals, families, and retirees attracted to the Four Corners area life style. The economy of the cumulative effects area and other nearby counties is predicted to expand but to stay distributed over the same industries that comprise it now. Population will continue to be concentrated in the communities of Durango, Bayfield, and Ignacio, but residential development will also continue to encroach on agricultural and forested lands and on oil and gas production facilities, especially in the central and northern parts of the La Plata County. Gas development is already spread throughout the area where the San Juan Basin overlaps the County. Residential development in those areas will in many places co-exist with gas well development.

The increase in broadly spaced, rural residential development in La Plata and Archuleta Counties is recognized as a problem on several counts. First, it reduces wildlife habitat. Second, it increases the cost of providing basic services, to residents such as roads and bridges, water, sewage control, electricity, and natural gas. Third, it degrades scenic views. "Current subdivision practices are developing the counties into smaller and smaller lots, gradually eroding the very qualities that attracted most residents." Finally, subdivision has increased the potential for conflict between residents and gas industry development. La Plata County government is promoting the development of district plans, which include substantial input from the district residents, and both the State and La Plata County have regulated the oil and gas industry to address residential development issues.

Community expansion would impact biological resources by changing land use and destroying habitat. Houses and new roads take away grazing and forage areas. Roads threaten migration routes, and animals of all types are often killed while attempting to cross roads. Human activity disturbs wildlife, can stress and weaken individual animals, and lowers reproduction rates. Community expansion will add noise, affect visual resources, decrease water quality and/or quantity, and add traffic. It may affect soils by replacing agriculture with subdivisions. It should not affect geologic resources except by encouraging the development of gravel resources. It should be an overall positive socio-economic impact because of increased and maintained job opportunities, diversification of the employment base, and increased tax revenues to various taxing entities that in turn provide services to residents.

3.19.4 Timber Harvest and Fire

The effects of timber harvest and fire suppression are of concern in the SJNF portion of the cumulative effects area. Timber harvest, when taken with other vegetation or ground-disturbing activities such as oil and gas development, would cumulatively affect soils, water quality, recreation, and particularly wildlife and their habitats. Records of past timber harvest activity indicate that between 1941

and 1996, 6,870 acres of ponderosa pine and mixed conifer were harvested in the Project Area on NFS lands. Approximately 1,535 acres of ponderosa pine and Douglas-fir were converted by harvests to different vegetation types including grasslands (103 acres); mountain shrub (55 acres); sagebrush (237 acres); Gambel oak (895 acres); pinyon-juniper (214 acres); riparian (5 acres); and barren (26 acres). These treatments benefited early successional wildlife species to the detriment of those that thrive on older forested ecosystems. There are also periodic timber harvests and thinning of small tracts of private and Reservation lands that contribute to perpetuating younger age classes of ponderosa pine, as has been the case over most of the SJNF.

A recent SJNF timber sale straddles the northeastern border of the Project Area. Cutting activities were conducted the summer of 2003, commercially thinning 157 acres of ponderosa pine. After harvest, a 500-acre prescribed burn is planned to reduce fuels and enhance pine regeneration. There are three additional vegetation treatment projects that are in various stages of planning: The FS is reviewing ponderosa pine fuels reduction treatments in the Fosset Gulch, Sauls Creek, and Lange Canyon areas. None of these activities is expected to individually or cumulatively affect wildlife detrimentally, but are designed to maintain the health and resilience of forested ecosystems. This is important when factoring the effects of impacting activities.

Fire suppression has been the overriding strategy for dealing with all fires in the Project Area since settlement in the late 1800s. This strategy has caused a somewhat unnatural mix of vegetation in terms of structure and density. There are many more small-diameter trees and shrubs present today than there would be had fire played a role in the last 100 years. This limits the moisture and sunlight available for grasses and forbs to grow. Fire exclusion results in fewer, larger stems of Gambel oak, for example. The changes in vegetation cover resulting from fire suppression are important when evaluating the cumulative impacts of management prerogatives and projects on wildlife.

Somewhat offsetting fire suppressions effects are prescribed fires conducted in the HDs over the past 16 years that treated close to 10,500 acres. The primary effect to vegetation from these burns was to top-kill Gambel oak. No significant changes in tree canopy closure or density occurred because of these burns, and consequently there was impact to wildlife species from these projects.

3.19.5 Livestock Grazing

The BLM and NFS lands in the Project Area are generally available as rangeland for livestock under permitted grazing allotments. A grazing allotment is an area of land designated and managed for the grazing of livestock by one or more livestock operators. The number of livestock (stocking rate or carrying capacity) and period of use are stipulated for each allotment. The carrying capacity is an estimate of the maximum number of animals (AUMs) a given area can support each year without damage to vegetation or related resources. One AUM is the amount of forage necessary to support one animal-unit for one month. An animal-unit is a 1,000-pound cow typically consuming 780 pounds of air-dry forage for one month.

The Project Area contains entire, or portions of, 7 BLM grazing allotments and 10 FS grazing allotments. Livestock grazing is permitted on 5 and 7 of the allotments, respectively. On BLM lands, 300 AUMs are permitted for livestock grazing and on NFS Lands, 2,899 AUMs are permitted. Grazing is permitted on approximately 68 percent of public lands within the Project Area. Due to the steep, rugged terrain, livestock can graze only about 35 percent of NFS lands within the Project Area. BLM lands are generally more accessible within the Project Area. Range monitoring shows an upward trend in terms of species composition and cover to the benefit of wildlife.

3.19.6 Recreation

A broad spectrum of recreation occurs year-round in the Project and cumulative effects area. Summer activities include hiking, mountain biking, hunting, fishing, camping, sightseeing, ATV riding, and wildlife viewing. Both BLM and SJNF are open seasonally to ATVs. CBM development's expansion of the road system, particularly on the SJNF, can attract additional motorized recreation use and could open up significantly more country. Areas easily accessible from Durango and Bayfield, such as Sauls Creek, are also expected to see increased day use for picnicking, hiking, mountain biking, and horseback riding because of increases in nearby populations. Increased human use of the project area over time can result in wildlife harassment and, in the extreme, habitat displacement. There is no indication that that is occurring now, but restriction of motorized human access to the Project Area must be considered as an option to mitigate these wildlife concerns in the future.

Table 3–196 Categories of Actions included in Cumulative Effects Analysis

General Category of Activity	Amount	Year	Resource of Concern
Past and Present Actions			
Oil and Gas Development	Acres or miles of disturbance	Year or period in which activity occurred	All
Community Expansion			Wildlife, land use, recreation, transportation, social and economic values
Timber Harvest and Fire			Wildlife, water, soils, vegetation
Livestock Grazing			Wildlife, water, soils, vegetation
Recreation			Wildlife, transportation
Reasonably Foreseeable Future Actions			
Oil and Gas Development	Acres or miles of disturbance	Year or period in which activity occurred	All
Community Expansion			Wildlife, land use, recreation, transportation, social and economic values
Timber Harvest and Fire			Wildlife, water, soils, vegetation
Livestock Grazing			Wildlife, water, soils, vegetation
Recreation			Wildlife, transportation

Recreational development is predicted to conflict with oil and gas development in the cumulative effects area during the project period. Most recreational development in the Four Corners is likely to occur in the towns themselves (e.g., Durango Recreation Center, Bayfield Recreation District) or in mountainous public lands (e.g., trails, trailhead facilities) where CBM development is now proposed. Some recreational facilities may be developed in association with residential

subdivisions (e.g., bike paths), but such development could be coordinated with oil and gas facilities. The Animas-La Plata project could include a large recreation development (reservoir) but would be outside of the current oil and gas development area. No expansion of the Lake Navajo Recreation Area is foreseen.

Cumulative effects from other activities on private lands, such as ranching and agriculture, cannot be quantified because of a lack of formal study, but are discussed qualitatively in this chapter.

3.19.7 Methane Seepage and Hydrogen Sulfide Impacts

In addition to methane seepage within the immediate Project Area (Section 3.3), seepage has been detected and shown to be increasing along the Fruitland outcrop west of the Project Area, particularly in the area of Valencia Canyon. This additional area is Area A and portions of Area B in the 3M Model, and extends along the Fruitland Outcrop from the Colorado – New Mexico State border to the Animas River. 3M simulation runs for the Colorado portion of the San Juan Basin predict that methane seepage in the cumulative effects area will increase and a peak rate would be reached in 2011. Infill CBM wells area expected to reduce seepage after 2011. Overall, within the cumulative effects area, the 3M Model predicts that seepage will peak at 10 MMcfd, or about twice the current level, and cumulative seepage is predicted to reach more than 100 bcf by 2030 (Questa 2000). This projected rate of methane seepage applies to all alternatives.

Projected new seepage locations are generally clustered around the area of existing seeps and would increase in areal extent as shown on Figure 3–8. Additional seepage could also emerge in the eastern Project Area as a result of the onset of CBM development in this relatively undeveloped area. Additional seepage is projected to also occur outside the Project Area in the area between Valencia Canyon and the Animas River. Areas of stressed or dying vegetation and associated impacts to wildlife habitat and soils are projected to approach approximately 640 acres within the Project Area, and to increase by some unquantified amount west of the Project Area. By following the same quantitative approach to vegetation die-off prediction outlined in Section 3.3.5, the additional area of vegetation die-off occurring between Valencia Canyon and the Animas River may approach 120 acres. Therefore, the cumulative impacts of methane seepage to vegetation, wildlife habitat, and soils could approach 760 acres over time. Alternatives 1, 2, and 7 could approach this level of impact. Alternatives 5 and 6 would have lower impact, probably not triggering methane seepage at the Fruitland outcrop, or presenting a lower probability of triggering impacts, because there would be very limited development of the eastern Project Area. If methane seepage were to emerge in the eastern Project Area, it would probably be limited to a small area of Fruitland outcrop within proximity of the 16 wells that would be developed under Alternative 5 within the 1½-mile Fruitland outcrop zone.

There would be approximately 40 domestic water wells that may be affected by methane seepage in the form of methane contamination. This number of wells would not increase in the cumulative effects area because there area no known

domestic wells tapped into the Fruitland aquifer outside of the immediate Project Area.

For all alternatives, additional impacts from hydrogen sulfide are difficult to predict based on experience. It is expected that highly localized hydrogen sulfide seeps may develop on the outcrop; however, to date, only two known hydrogen sulfide seeps have been identified in the Project Area. Only one of the seeps may be tied to CBM development.

3.19.8 Geology and Mineral Impacts

For all alternatives, the cumulative effects on the surface geologic environment would be minimized if proper techniques for well pad and facility siting, construction, and reclamation are used. Development projects would require restoration of disturbed lands and would minimize alterations to topography. Standard stipulations and project- and site-specific construction and reclamation procedures would be required for additional development on federal and tribal lands. These measures would further minimize cumulative impacts on the surface geologic environment, including existing landslide deposits and areas with high landslide risk. Although reasonably foreseeable actions would be unlikely to trigger geologic hazards such as landslides, mudslides, debris flows, or slumps, an incremental increase in cumulative impacts associated with geologic hazards could occur.

Paleontological resources are non-renewable resources that can become exhausted. Although fossils are rarely one-of-a-kind, a limited number of specimens are preserved in any geologic formation and these cannot be used for scientific study, if damaged, destroyed, or removed without proper scientific documentation. The BLM, FS, and SUIT have applied mitigation measures to surface disturbing activities in the cumulative effects analysis area that would protect paleontological resources and the scientific values they contain. Cumulatively, anticipated development activities would not be expected to noticeably affect paleontological resources, provided the mitigation measures identified are implemented.

Slope stability concerns in the cumulative effects area are as described for the Project Area. Wherever steep slopes and highly erosive soils are encountered, reasonably foreseeable future actions, such as CBM development, vegetation management, livestock grazing, wildfires, and prescribed burning, could cause an increase in slope failures and associated sedimentation and erosion. The probability of slope failures occurring outside the Project Area is unknown, but operators developing Southern Ute mineral leases generally utilize the same engineering standards and mitigation approaches described below to minimize slope failures. The same holds true for construction practices on private and state land. However, through not quantifiable, even if projects are well engineered and mitigation measures described earlier in this chapter are implemented, potentially unstable slopes subjected to the removal of vegetation or facility construction could fail. Unplanned actions such as wildfires, prolonged wet periods, or large storms could destroy vegetation or introduce excessive precipitation that would trigger slope movement.

Development of non-CBM oil and gas resources likely would not noticeably affect CBM development in the cumulative effects analysis area. Similarly, CBM development would not noticeably affect development of non-CBM oil and gas resources. These development activities would be compatible, and may share some facilities, such as roads, pipelines, or utilities. Collateral use of some facilities would minimize surface disturbance and the use of construction materials for both activities.

3.19.9 Groundwater Impacts

Groundwater extraction may ultimately affect wildlife, sources of domestic and irrigation water, and possibly riparian areas through the drying of seeps and springs that are connected to the Fruitland Formation aquifer. This impact has the potential to occur along the Fruitland Formation outcrop both inside and outside the Project Area. The area of potential impact stretches from the Colorado – New Mexico border east to the Piedra River. This area of greatest concern for this impact is the Fruitland outcrop area between Valencia Canyon Gap on the west to the Piedra River in the eastern Project Area (Figure 3–8). Alternatives 1, 2, and 7 would all have similar levels of potential to effect springs and seeps within the cumulative effects area. Alternatives 6 and 5 would have somewhat lesser potential to affect springs and seeps than the other three alternatives because of the very limited CBM development that would occur in the eastern Project Area. The actual number of springs and seeps that would be affected by CBM development cannot be quantified because this is an indefinite impact that has not been observed to date. Springs and seeps have been identified and mapped and are monitored for changes in water chemistry and flow.

Deep injection effects from the disposal of CBM well produced water throughout the cumulative effects area, such as mixing different water types or pressuring the receiving formation, will not be observed in the human environment, and will have no effects on other resources.

Groundwater draw down at the outcrop that would result from CBM development may also affect as many as 40 domestic water wells that tap the Fruitland Formation for their supply. There are no known domestic wells that tap the Fruitland aquifer outside of the Project Area, so the number of wells that may be impacted by CBM development within the larger cumulative effects area would not increase.

3.19.10 Surface Water Impacts

Unless specified in a section below, the cumulative effects analysis area encompasses that portion of the Upper SJB fourth-level watershed (USGS HUC 14080101) and the Piedra River fourth level watershed (USGS HUC 14080102) above Navajo Dam in New Mexico, and the Animas fourth-level watershed (USGS HUC 14080104) above Bloomfield, New Mexico.

Operators use pits to contain drilling fluids during drilling and completion. These pits could fail or overflow, allowing drilling fluids to traverse the well pad and flow into surface drainages. Effects to water quality would depend on the loca-

tion of the pit in relation to surface drainages, as well as on the amount of fluids released and the adequacy of spill containment and cleanup procedures. The potential for spills of drilling fluids increases with the number of wells drilled under the alternatives and the number of wells drilled in the cumulative effects area. The number of new wells proposed in the in the cumulative effects area is approximately 1,600 in contrast to the 286 wells proposed in the Project Area. With this increase in number of wells, the potential for spills of drilling fluids or other chemicals used in the drilling and completion of wells would increase commensurately within the cumulative effects area. Detailed design of well pads, pipelines, and roads as well as spill contingency plans would be completed during the site-specific analysis on federal jurisdiction during the APD stage of planning.

Vehicle refueling areas could also provide a source of contamination to the quality of surface water. Within the cumulative effects area, the number of refueling areas would increase, so it follows the potential for spills would also increase. These effects would be minimized under all alternatives and within the cumulative effects area on federal lands and tribal lands by locating refueling stations away from surface drainages and water bodies and storing fuels in bermed areas.

Facility construction would require certification under the NPDES general permit, and materials handling and spill prevention procedures would be implemented to contain spills before they could reach surface waters. The companies would also develop site-specific SPCC plans for construction and operation of the facilities to be located on each well pad. These regulatory processes and BMPs would be implemented on federal and tribal lands to minimize impacts to surface water quality from potential spills and leaks. Similar BMPs would be utilized elsewhere and enforced by the State of Colorado in the cumulative effects area on private and state jurisdictions. Therefore, overall the potential for spills and leaks to reach surface water bodies would be long term but minor.

There would be a long-term risk of contamination in areas where produced water pipelines cross-existing landslides or landslide hazard areas. If new construction were to trigger any movement of landslides, pipelines could either rupture and leak, or break and spill large quantities of wastewater on the landscape or into Project Area streams. Leaking pipelines could also saturate the ground causing more landslide movement and additional damage due to ruptured pipelines. Depending on the location, leaks or catastrophic pipeline failures could take many hours to reach and repair, allowing spills to cause much erosion and chemical contamination damage to the environment.

Alternative 1 involves construction of 19 miles of pipeline on landslide hazard areas or pre-existing landslides, of which 14 miles of new pipeline are proposed on National Forest in the Lower Piedra watershed. This watershed is remote, steep, potentially unstable, and dissected by numerous streams. Consequently, there is high risk that pipeline construction across the landslide hazard areas could result in produced water spills that could reach streams. Alternative 2 involves constructing 42 miles of pipeline across high landslide hazard areas. Beaver Creek (10 miles), Lower Los Pinos (8 miles), and Lower Piedra (18 miles) watersheds would have the highest risk of impact due to the large amount of proposed pipeline construction across landslide hazard areas in these watersheds.

Alternatives 5, 6, and 7 involve less construction of pipeline in high landslide area and thus present a lower potential for pipeline rupture.

The risk of pipeline ruptures elsewhere in the cumulative effects area cannot be estimated due to a lack of data. In general, however landslide hazard areas occur within 1½ miles of the Fruitland outcrop and in the more mountainous eastern half of the cumulative effects area. Cumulative impacts would be difficult to predict, but would be greatest if one or more pipeline failures occurred simultaneously in the same watershed. Very wet weather conditions such as winters with above average snow water content, or wetter than average summers could provide conditions that promote the triggering of landslides that may lead to multiple failures of pipelines.

Soil loss and sedimentation as a result of CBM development and other potentially impacting activities is also of concern throughout the cumulative effects area. To analyze surface water quality cumulative effects and potential water quality effects that would result of well pad, road, and pipeline construction, the size of the cumulative effects area was enlarged to 765,000 acres. (The immediate Project Area includes or touches part of thirteen (13) 6th level watersheds. In contrast the cumulative watershed effects analysis area assesses forty four (44) 6th level watersheds.) The cumulative effects analysis was extended upstream on the main rivers far enough to assess if the rivers were heavily impacted when they entered the Project Area. The cumulative effects area was then extended downstream to where the effects of CBM development became minimal compared to the whole watershed.

The activities analyzed in the watershed cumulative effects analysis were activities that disturb the soil or vegetation, including past and present roads, fires, timber and fuel treatments, mining, and construction activities across all ownerships. The proposed action, Alternative 1, was used for detailed analysis, and additional analysis was conducted using Alternative 2 (maximum development) in concert with CBM development within the bounds if the Southern Ute Indian Reservation (1,600 new CBM wells). Since some activity impacts recover over time, impacts were modeled at three-year intervals terminating in 2024.

The results of the cumulative watershed analysis are displayed Table 3–197. To determine the point where detectable negative cumulative effects could occur, a threshold of 20 percent of any watershed being impacted by activities rated high or moderate impact was used. If less than 20 percent of the watershed had high or moderate impact activities, the risk of negative cumulative watershed effects was considered low. The results of the analysis show that no watersheds within the Project Area will be above the 20 percent impact threshold, considering past, proposed and reasonably foreseeable actions

Table 3–197 Percent of Watershed with High and Moderate Impact Activities for Past, Present and Reasonably Foreseeable Activities Compared to Cumulative Effect Threshold of 20 Percent

		Portion of Watershed with High or Moderate Impact Activities by Year (percent)						
HUC 6 #	HUC 6 name	2006	2009	2012	2015	2018	2021	2024
140801011001	Sandoval Canyon	14.8	14.5	14.5	14.5	14.5	8.4	8.4
140801011002	Navajo Reservoir Inlet-San Juan River	2.0	2.0	2.0	2.0	2.0	2.0	2.0
140801011003	Sambrito Creek	3.3	3.3	3.3	3.3	3.3	3.3	3.3
140801011501	Middle Los Pinos River-Red Creek	84.4	2.9	1.0	1.0	1.0	1.0	1.0
140801011502	Bear Creek	1.2	1.3	0.9	0.9	0.9	0.9	0.9
140801011503	Los Pinos River-Bayfield	4.3	4.3	3.4	3.4	3.4	3.2	3.2
140801011601	Upper Beaver Creek	6.7	6.5	3.6	3.0	1.6	1.6	1.6
140801011602	Middle Beaver Creek	4.0	9.4	2.2	2.2	2.2	2.2	2.2
140801011603	Lower Beaver Creek	2.7	2.1	2.1	2.1	2.1	2.1	2.1
140801011701	Dry Creek	6.8	3.5	3.5	3.5	3.5	3.5	3.5
140801011702	Los Pinos River-Rock Creek	4.8	4.8	4.8	4.8	4.8	4.8	4.8
140801011703	Ute Creek	10.5	3.1	3.1	3.1	3.1	3.1	3.1
140801011704	Upper Spring Creek	2.8	2.8	2.8	2.8	2.8	2.8	2.8
140801011705	Lower Spring Creek	4.7	4.7	4.7	4.7	4.7	4.7	4.7
140801011706	Lower Pinos River-Shellhammer Ridges	6.0	6.0	6.0	6.0	6.0	6.0	6.0
140801011801	Los Pinos River-La Boca Canyon	5.5	5.5	5.5	5.5	5.5	5.5	5.5
140801012204	Trail Canyon	8.9	6.5	6.3	6.3	6.3	6.3	6.3
140801020301	Upper Devil Creek	3.1	5.2	2.2	2.2	2.2	2.2	2.2
140801020302	Lower Devil Creek	8.9	8.4	8.4	5.0	5.0	5.0	5.0
140801020401	Martinez Creek-Dutton Creek	18.4	12.5	2.4	2.4	1.9	1.6	1.6
140801020402	Upper Stollsteimer Creek	19.0	17.3	15.5	15.5	15.5	15.3	15.3
140801020403	Stollsteimer Creek-Dyke Valley	7.1	7.2	6.2	6.2	6.2	6.2	6.2
140801020404	Middle Stollsteimer Creek	14.7	5.5	5.5	3.3	3.3	3.3	3.3
140801020405	Lower Stollsteimer Creek	1.7	2.7	2.5	1.5	1.5	1.5	1.5
140801020501	Yellowjacket Creek	15.6	18.9	2.3	2.1	1.9	1.9	1.9
140801020502	Piedra River-Stollsteimer	2.6	2.6	2.6	2.6	2.6	2.6	2.6
140801020503	Piedra River-Navajo Reservoir Inlet	2.0	1.9	1.9	1.9	1.9	1.9	1.9
140801040504	Upper Animas Valley-Trimble	33.5	5.3	5.3	5.2	5.2	5.0	5.0
140801040601	Junction Creek	10.2	6.5	6.5	6.3	6.3	6.3	6.3
140801040602	Upper Lightner Creek	16.6	16.0	0.4	0.4	0.4	0.4	0.4
140801040603	Lower Lightner Creek	2.3	2.3	2.3	2.3	2.3	2.3	2.3
140801040604	Animas River-Spring Creek	7.5	5.5	5.5	5.5	5.5	5.3	5.3
140801040701	Middle Animas Valley-Smelter Mountain	7.5	7.5	7.5	7.5	7.5	7.5	7.5
140801040702	Basin Creek	3.6	4.0	2.7	2.7	2.7	2.7	2.7
140801040703	Middle Animas Valley-La Posta	4.0	4.0	4.0	4.0	4.0	4.0	4.0
140801040704	Middle Animas Valley-Bondad	5.7	5.7	5.7	5.7	5.7	5.7	5.7
140801040804	Upper Florida River-Red Creek	59.1	2.2	2.2	2.2	2.2	2.2	2.2
140801040901	Lower Florida River-Ticalotte	3.7	3.6	3.6	3.6	3.6	3.6	3.6
140801040902	Lower Florida River-Cottonwood Gulch	4.0	4.0	4.0	4.0	4.0	4.0	4.0
140801040903	Lower Florida River-Salt Creek	6.4	4.2	4.2	4.2	4.2	4.2	4.2
140801040904	Lower Florida River-Cow Canyon	6.9	6.9	6.9	6.9	6.9	6.9	6.9
140801041001	Cox Canyon	4.3	4.3	4.3	4.3	4.3	4.3	4.3
140801041002	Hat Park Canyon	5.0	5.0	5.0	5.0	5.0	5.0	5.0
140801041003	Animas River-Six Shooter Canyon	4.7	4.7	4.7	4.7	4.7	4.7	4.7

No 6th level watershed with CBM development activities is expected to have detrimental cumulative effects; impacts for both Alternative 1 and Alternative 2 were below threshold. Alternatives 5, 6, and 7 would result in impacts that are less than Alternative 1, and would also be under threshold. CBM activities, in conjunction with past and reasonably foreseeable activities, are below the threshold where risk of cumulative watershed effects is expected for each 6th level watershed where CBM activities are proposed. Stollsteimer Creek is approaching the threshold, and is also being evaluated by State of Colorado for sediment impacts. If Stollsteimer Creek is found to be impaired by sediment additional mitigation beyond that specified in this EIS may be required.

Water would be consumed for drilling throughout the cumulative effects area as a result of the drilling of approximately 1,600 new wells. Cumulative effects associated with Alternative 1 consider the consumptive use of water supplies for existing and proposed oil and gas development in the Project Area within the bounds of the Southern Ute Reservation. The projected consumption from the SUIT EIS is 535 acre-feet, or 27 acre-feet per year. Thus, the cumulative annual consumption of surface water supplies, including this project, would equal approximately 40 acre-feet per year. Surface waters in the cumulative effects analysis area should not be reduced in quantity because the water requirements for well drilling and completion would be acquired from already appropriated irrigation sources.

Water consumed from drilling and completing CBM wells under Alternative 2 would be greater than the effects discussed for Alternative 1 because of the higher level of development in the Project Area. Alternative 5, 6, and 7 would result in less consumptive use of surface water resources than Alternatives 1 and 2.

Dewatering of the Fruitland Formation is necessary to extract methane gas. Dewatering this aquifer would result in estimated annual surface water losses of about 140 acre-feet/year from the Florida, Pine, and Animas Rivers, and 15 to 60 acre-feet/year from the Piedra River. Surface water losses would continue for several centuries (Cox et al. 2001). CBM development activity on the Southern Ute Indian Reservation (approximately 1,300 new wells) is projected to intercept about 37 acre-feet of discharge to the Animas River (ibid).

3.19.11 Soil Impacts

In addition to the impacts of CBM development in the Project Area on soils, cumulative soils impacts also result from other ground-disturbing actions including the Missionary Ridge wildfire, timber harvest, OHV use, agriculture and rangeland activities, and aggregate (sand and gravel) mining. Reasonably foreseeable future activities, such as projected residential, commercial, and industrial development, identified in the 2001 La Plata County Impact Report for oil and gas development, are also considered when evaluating cumulative soils impacts.

The quantitative analysis is limited to oil and gas development, which is quantified for the entire cumulative effects analysis area. The extent and timing of some effects, especially on private lands, are difficult to quantify because of a lack of data.

Cumulative soil erosion impacts in the bounds of the SUIT Reservation are similar to the effects described for this project. CBM and conventional gas facility construction and operation, especially on soils that have high potential for wind and water erosion, would trigger increased erosion and sedimentation in surface water because of vegetation clearing, heavy equipment traffic, wind, and precipitation. Oil and gas development within the bounds of the Southern Ute Reservation would result in a maximum of 447 new wells constructed in areas of highly erosive soils, impacting a maximum of 1,368 acres (1.6 percent of the SUIT FEIS study area) in the short term and 921 acres (1.1 percent of the SUIT FEIS study area) in the long term. Existing and proposed CBM development in the Project Area under Alternative 1 would impact 153 acres on soils with high potential for wind or water erosion in the short term (less than 0.1 percent of the Project Area), and 97 acres (less than 0.1 percent of the Project Area) in the long term. Oil and gas development would cumulatively affect 1,521 acres during construction and 1,018 acres during operation and maintenance on highly erosive soils, which is approximately 0.2 percent of the cumulative effects analysis area for both development phases.

Soil erosion impacts would be partially mitigated on both federal and Tribal jurisdictions by implementing mitigation measures that include graveling road surfaces to avoid dust and soil loss to wind erosion; revegetating or covering any soil stockpiles that would remain for extended periods to avoid significant wind and water erosion; installing slope breaks and silt fences on slopes to slow and filter storm water runoff that might carry exposed soils to surface water drainages; timely reclamation of disturbed areas to minimize erosion after construction of facilities; and avoiding locations having highly erosive soils where possible.

The Missionary Ridge fire north of the Project Area exposed highly erosive soils in areas where vegetative cover previously held the soil in place. Since the fire, significant erosion and debris flows have occurred within the burned area. Soils eroded from the burn area, although they originate outside the cumulative effects area, reach the lower gradient channels of the Florida, Animas, and Los Pinos Rivers, and short-term changes in water quality have been observed (FS 2003a). Furthermore, the flow of water over the burn area could carry sediment into the Project Area, which would contribute to any sedimentation caused by CBM development. Reclamation and treatment in the burn area, such as aerial seeding and log erosion barriers, have mitigated some of the erosion and will continue to do so in the future until vegetation becomes reestablished. The log erosion barriers installed near Lemon Reservoir have proved successful in slowing free flow of water and sediment downslope and fostering infiltration into the soil (FS 2002a).

The projected residential, commercial, and industrial growth anticipated within the cumulative effects analysis area would all contribute to localized erosion. The impact is considered minor, however, and is not quantifiable for this study.

Soil erosion in the cumulative effects analysis area realized under Alternative 2 would be greater than the impacts discussed for Alternatives 1 and 7 because of the higher level of development in the Project Area. The increased surface disturbance would cause greater exposure of erosive soils to wind and water, resulting in higher levels of erosion. Alternative 5 would result in less soil erosion in

the cumulative effects analysis area than Alternatives 1, 2, 6, and 7. Soil erosion in the cumulative effects analysis area realized under Alternatives 6 would be less than the impacts discussed for Alternatives 1 and 2 because of the exclusion of surface development within the HD Mountains Roadless Area and the exclusion of federal mineral lease development within the Fruitland outcrop buffer zone

Topsoil loss from existing and proposed CBM development in the SUIT FEIS study area is similar to the impact described for the Project Area. Areas of prime farmland would be affected by conversion of land from agricultural production to gas facilities. Prime farmland occurs in the northeastern quarter of the SUIT study area. Oil and gas development within the bounds of the Reservation would result in a maximum of 30 new wells that could affect prime farmland, which would affect a maximum of 92 acres (0.44 percent of the prime farmland within the SUIT FEIS study area). Less than 1 percent of existing and proposed CBM wells in the Project Area are located on farmland used for crop production, all in a small area along the upper section of the Florida River in the Project Area and near Bayfield.

3.19.12 Vegetation Impacts

Table 3–198 and Table 3-78 which represent maximum development and the no-action alternative bound cumulative vegetation removal due to existing and proposed oil and gas development within the cumulative effects area. Other activities that would contribute to cumulative vegetation impacts in the Project Area are not quantifiable because of lack of study and associated data. These other factors are addressed qualitatively and include sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development.

The vegetation types that would be most impacted by CBM development are grasslands, sagebrush, pinyon juniper, and ponderosa pine. Future CBM development would remove about 9,000 acres of vegetation in addition to the 16,500 acres already impacted.

Each of the alternatives would contribute to cumulative effects to HSSs in the cumulative effects analysis area (Table 3–200 and Table 3–201). Project activities that remove vegetation would also remove HSSs and reset the process of ecological succession. Other activities that contribute to cumulative effects to HSSs including sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development are not quantified because of a lack of data regarding their impacts. Effects to HSSs from these activities would be in addition to the cumulative effects that have been quantified. Cumulative vegetation impacts would approach six-percent of grasslands, riparian areas, mountain shrub and sagebrush vegetation types in all alternatives due primarily to the extent of development on private lands and lands within the boundaries of the Southern Ute Reservation. Cumulative impacts to other vegetation types would range from 0.3 to approximately 3 percent of each of the representative vegetation types. Approximately 3 percent or less of the forested vegetation types would be cumulatively impacted by CBM development.

Table 3–198 Cumulative CBM Impacts to Vegetation — Maximum Development

Vegetation Type	Project Area: Existing Impact (acres)	Project Area: Future Impact (acres)	SUIT Study Area: Existing Impact (acres)	SUIT Study Area: Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	128	4,155	1,192	5,761	6.3
Sagebrush	221	94	3,897	1,118	5,330	6.2
Pinyon-Juniper	229	361	5,174	3,439	9,204	5.2
Mountain Shrub	21	42	865	248	1,176	6.2
Gambel Oak	162	325	204	404	1,095	3.7
Ponderosa Pine	310	589	354	710	1,963	3.8
Mixed Conifer	9	85	0	0	94	2.1
Aspen	8	29	0	0	37	2.8
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	71	0	0	184	2.0
Barren	117	20	0	0	137	5.9
Water	1	0	0	0	1	0.5
Total	1,489	1,746	14,869	7,383	25,487	5.3

Table 3–199 Cumulative CBM Impacts to Vegetation — No Action Alternative

Vegetation Type	Project Area: Existing Impact (acres)	Project Area: Future Impact (acres)	SUIT Study Areas: Existing Impact (acres)	SUIT Study Areas: Future Impact (acres)	Total (acres)	Portion of Vegetation Type (percent)
Grasslands	286	21	4,155	1,192	5,654	6.2
Sagebrush	221	55	3,897	1,118	5,291	6.2
Pinyon-Juniper	229	94	5,174	3,439	8,937	5.0
Mountain Shrub	21	5	865	248	1,139	6.0
Gambel Oak	162	30	204	404	799	2.7
Ponderosa Pine	310	105	354	710	1,479	2.9
Mixed Conifer	9	3	0	0	12	0.3
Aspen	8	0	0	0	8	0.6
Riparian/Wetlands	11	3	220	272	506	5.7
Agriculture	113	39	0	0	153	1.6
Barren	117	7	0	0	124	5.3
Water	1	0	0	0	1	0.5
Total	1,489	362	14,869	7,383	24,103	5.0

Table 3–200 Cumulative CBM Impacts to Habitat Structural Stages — Maximum Development

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.4	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.2	5.2	0.0	5.2	5.2	0.0	0.0	5.2
Mountain Shrub	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Gambel Oak	0.0	0.0	0.0	3.7	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	3.2	3.3	2.5	3.8	3.8	2.6	4.8	3.8
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.1	1.5	0.4	5.3	1.8	2.3	0.0	2.1
Aspen	0.0	0.0	0.0	0.0	0.0	3.6	3.4	1.3	4.1	1.8	0.2	0.0	2.8
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
Barren	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.9
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.7	6.4	6.2	5.7	4.2	5.2	5.1	1.3	4.7	4.3	2.3	4.8	5.3

Table 3–201 Cumulative CBM Impacts to Habitat Structural Stages — No Action Alternative

	Loss of Habitat Structural Stages (percent)												
Vegetation Type	n/a	1M	1T	2S	2T	3A	3B	3C	4A	4B	4C	5	Total
Grasslands	0.0	6.2	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Sagebrush	0.0	0.0	0.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.2
Pinyon-Juniper	0.0	0.0	0.0	0.0	0.0	5.0	5.0	0.0	5.0	5.1	0.0	0.0	5.0
Mountain Shrub	0.0	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0
Gambel Oak	0.0	0.0	0.0	2.7	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7
Ponderosa Pine	0.0	0.0	0.0	0.0	0.0	2.5	2.8	2.4	2.8	3.0	2.4	2.8	2.9
Mixed Conifer	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.3	0.3	0.0	0.0	0.3
Aspen	0.0	0.0	0.0	0.0	0.0	0.7	0.9	0.0	0.3	0.3	0.0	0.0	0.6
Riparian	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	5.7
Agriculture	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Barren	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3
Water	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Total	2.3	6.2	6.2	5.4	3.0	5.0	4.9	0.9	4.2	3.8	0.5	2.8	5.0

Areas reclaimed after CBM development would differ substantially from undisturbed areas in terms of HSS. The short-term cumulative impact would consist of a loss of later seral stages (4A, 4B, and 4C) and an increase in early and mid-seral stages (1M, 2S, 3A, 3B, and 3C).

Much of the discussion of cumulative effects to vegetation and HSSs is also relevant to wetlands and riparian areas. Sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development have likely impacted wetlands and riparian areas via habitat loss or degradation, road development, and degradation of water quality. These types of activities are expected to increase in number and frequency within the cumulative effects area commensurate with the growth in regional population. The USCAE permitting process is

designed in part to minimize the cumulative effects of filling wetlands; therefore, minimal direct loss of wetlands from this and other projects is expected in the future. Cumulative degradation of wetlands and riparian areas by sediment would be minimized using BMPs and mitigation measures developed on site during the APD evaluation process.

Interim and permanent vegetation restoration would occur in areas of existing and proposed CBM development. These activities are conducted to ensure that CBM-related disturbances are temporary and do not cause permanent loss of vegetation and productivity in the cumulative effects area. Still, many other disturbances that occur in the cumulative effects area are not subject to similar restoration requirements and have greater potential to cause permanent loss of vegetation, introduction of noxious weeds, and loss of vegetative productivity.

The cumulative effect of noxious weed infestations has not been quantified; however, agriculture and residential development have all played a substantial role in the introduction and spread of noxious weeds. Agricultural and residential uses are widespread in the cumulative effects analysis area and are not subject to the same strict weed control measures as is oil and gas development. CBM development would be subject to mitigation measures for weed control, minimizing any cumulative impacts of noxious weeds on vegetation. Ongoing agricultural and residential land uses would continue to be the primary causes for introduction and spread of noxious weeds throughout the Project and cumulative effects area.

The cumulative loss of old growth stands to CBM development on NFS lands in the Project Area is only slightly higher than the Project effects shown in the Vegetation Section of this chapter. Ten acres of field-verified old growth were lost to the construction of FSR 615, one well pad, and a short segment of unnumbered road accessing this well pad in the past. Although only a small loss of old growth can be quantified, a much larger amount has been lost over the past century to timber harvest and wildland fire. Of the 34,690 acres of ponderosa pine stands in the Project Area, a larger proportion probably was old growth before Euro-American settlement and development of the Project Area.

Similar patterns in loss of old growth ponderosa pine forests are seen across the entire SJNF. Of the 260,940 acres of ponderosa pine stands on the SJNF, 15,020 acres (5.8 percent) are currently old growth (FS 2003e). A large proportion of the old growth ponderosa pine has been harvested, mostly with partial cuts that removed the largest trees from the affected stands, or lost due to wildland fire. Since 1990, 314 acres of old growth ponderosa pine have been harvested on the SJNF, and 332 acres were burned during the Missionary Ridge Fire in 2002 (FS and BLM 2003).

There has been a general reduction in the extent of old growth ponderosa pine stands. More recently, most remaining old growth stands have been protected. The extent of stands of old growth ponderosa pine should increase in the future. Old growth ponderosa pine stands totaling 1,080 acres are within the analysis areas of future timber sales on the SJNF (FS and BLM 2003), although it is expected that few, if any, of these stands will actually be harvested. Approximately 365 acres of old growth pine fall within the boundaries of existing oil and gas

leases on the western side of the SJNF outside of the Project Area. No data are available for the eastern side of the SJNF (FS and BLM 2003). Oil and gas development may or may not occur within these stands in the future.

There are no similar inventories of old growth on non-federal jurisdictions elsewhere in the Project Area or within the bounds of the Southern Ute Indian Reservation. Therefore, the effects of past, current and future CBM or other development activities on old growth forests cannot be quantified in the entire 547,000-acre cumulative effects area.

The incremental effects of CBM development on ecological processes, such as fire and insect and disease infestations, are primarily cumulative because of the long period and widespread, landscape scale of these processes. Natural fire regimes have been and will continue to be altered. CBM development would likely result in increased firefighting efforts across the Project Area to protect facilities and further alter natural fire regimes. Future fire regimes are more likely to be dictated by the extent of residential development on private lands, the continuing accumulation of unnaturally high fuel loads in many vegetation types, and long-term weather trends, such as drought. Likewise, insect and disease infestations across the landscape would be more affected by activities beyond the scope of the current project than by project activities. Current and future droughts will be the primary cause of *Ips* beetle outbreaks. Mitigation measures would be used to reduce the potential for the proposed project to affect beetle outbreaks.

The cumulative effects to federally listed threatened, endangered, and proposed plant species are presented on Table 3–202. The cumulative effects to FS and BLM sensitive plant species are presented on Table 3–203.

Table 3–202 Federally Listed Threatened, Endangered, and Proposed Plant Species — All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Knowlton's Cactus	Implementation of any of the alternatives is not likely to have any direct or indirect effect on Knowlton's cactus. Preconstruction surveys would be implemented in areas of suitable habitat that would be disturbed by activities associated with any of the alternatives. In the event that any previously unknown occurrences of Knowlton's cactus are discovered during these surveys, the FWS would be consulted, and the location of the occurrence and an appropriate buffer would be avoided by all ground-disturbing activities.	Implementation of any of the alternatives is not likely to have any cumulative effect on Knowlton's cactus. Undocumented occurrences of this species may have been affected by past CBM development or other ground-disturbing activities because suitable habitats may not have been surveyed.	Implementation of the proposed action, as described above, may affect, but is not likely to adversely affect, Knowlton's cactus, based on discountable effects. This determination is based on the lack of known occurrences of this species in the Project Area, negative results from surveys in the Project Area, and the avoidance of buffer areas surrounding any population of Knowlton's cactus that are found during preconstruction surveys

Table 3–203 Forest Service and BLM Sensitive Plant Species — All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Aztec Milk-vetch	No known occurrences of this species would be disturbed. 11 to 234 acres (less than 1 to 2 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Aztec milk-vetch were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Aztec milk-vetch.	Implementation of any of the alternatives may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for the Aztec milk-vetch. This determination is based on the low likelihood that this species occurs within the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and implementation of avoidance measures if new occurrences are discovered.
Giant Helleborine	No known occurrences of this species would be disturbed. No suitable habitat for this species would be disturbed under any of the alternatives. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the giant helleborine were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible. Construction in or near suitable wetland or spring habitats may alter or interrupt the hydrologic conditions that support this species. Groundwater withdrawal associated with the project may result in decreased spring and seep flows in areas that support this species. Increased access would increase opportunities for collection of this species by hobbyists.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the giant helleborine. Groundwater withdrawals cause the cumulative reduction of spring and seep flows.	Implementation of any of the alternatives may adversely impact individuals, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for the giant helleborine. This determination is based on the low likelihood that this species occurs within, or extensively within, the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and the implementation of avoidance measures if new occurrences are discovered.
Pagosa Skyrocket	No known occurrences of this species would be disturbed. From 83 to 941 acres (less than 1 to 2 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Pagosa Skyrocket were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Pagosa skyrocket.	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for Pagosa skyrocket. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

Table 3–203 Forest Service and BLM Sensitive Plant Species — All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Pagosa Springs Bladderpod	No known occurrences of this species would be disturbed. 46 to 806 acres (less than 1 to 4 percent) of suitable habitat for this species would be disturbed. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the Pagosa Springs bladderpod were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing, and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Pagosa Springs bladderpod.	Implementation of any of the alternatives would have no impact on the Pagosa Springs bladderpod on federal jurisdiction. This determination is based on the low likelihood that this species occurs within the Project Area, the implementation of pre-construction surveys in suitable habitats that would be disturbed by each of the alternatives, and the implementation of avoidance measures if new occurrences are discovered.
Large Flower Triteleia (*Triteleia grandiflora*)	The types of effects to this species are the same among the alternatives and vary only according to the amount of habitat disturbed by each alternative. In general, alternatives that involve more wells and facilities have more potential to affect this species and its habitats than are alternatives with fewer wells and facilities. Potential effects to large flower triteleia include injury or death to individuals resulting from trampling or crushing by machinery, destruction of habitat, and introduction of non-native species. Disturbance to habitat may also create conditions that are conducive to establishment of non-native plant species that can out-compete native species for habitat resources, which could lead to reduction in numbers and possible local extinction of this species. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Pre-construction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the to large flower triteleia were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the large flower triteleia	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for large flower triteleia. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

Table 3–203 Forest Service and BLM Sensitive Plant Species — All Alternatives

Species Name	Direct and Indirect Effects	Cumulative Effects	Determination
Missouri Milkvetch (*Astragalus missouriensis* var. *humistratus*)	The types of effects to this species are the same among the alternatives and vary only according to the amount of habitat disturbed by each alternative. In general, alternatives that involve more wells and facilities have more potential to affect this species and its habitats than are alternatives with fewer wells and facilities. Potential effects to Missouri milkvetch include injury or death to individuals resulting from trampling or crushing by machinery, destruction of habitat, and introduction of non-native species. Disturbance to habitat may also create conditions that are conducive to establishment of non-native plant species that can out-compete native species for habitat resources, which could lead to reduction in numbers and possible local extinction of this species. Alternative 2 would involve the largest amount of disturbance, followed by Alternatives 1 and 5, in decreasing order. Preconstruction surveys would be implemented in areas of suitable habitat. If any previously unknown occurrences of the to Missouri milkvetch were discovered, the location of the occurrence and an appropriate buffer would be avoided to the extent possible.	Cumulative effects from past and present actions include CBM development, land management activities (timber harvest, livestock grazing and other factors), and recreational use. These same effects are expected to continue in the future within the Project Area and surrounding lands. Each of the alternatives would have minimal cumulative effects on the Missouri milkvetch.	Implementation of any of the action alternatives for this project, may adversely impact individuals on federal lands, but is not likely to result in a loss of viability on the planning area, nor cause a trend toward federal listing or a loss of species viability range wide for Missouri milkvetch. This determination is based on the likely occurrences of this species within the Project Area, and the recognition of suitable habitat for this species within the Project Area. It also takes into account the fact that site-specific pre-disturbance plant surveys will be implemented on federal lands within the Project Area that contain potential habitat for this species, and if the species is found avoidance measures will be implemented.

3.19.13 Wildlife Impacts

3.19.13.1 Management Indicator Species

Management indicator species (MIS) are utilized to evaluate the environmental impacts of CBM development on wildlife species. Within the cumulative effects area, no more than 6 percent of suitable habitat for any MIS would be directly affected by CBM development (Table 3–204 and Table 3–205). CBM development would affect individuals but would not impact forest-wide population trends of MIS (Appendix J). Of greater concern is the loss of habitat effectiveness and displacement that would occur because of continued residential and CBM development within the western portion of the cumulative effects area. Residential development would be more pervasive in its effect, whereas CBM roads and faculties would be closed and gated to reduce wildlife-human conflict. Big game would be the species most affected by continued residential development (Appendix J).

3.19.13.2 Threatened and Endangered Species

3.19.13.2.1 Bald Eagle

Within the 547,600-acre cumulative effects area, there are three bald eagle nests and approximately 27,500 acres of bald eagle winter concentration areas (BLM et al. 2002).

The cumulative effects of the Proposed Action combined with all other existing and proposed oil and gas development would result in a total surface disturbance of 826 acres (3 percent) of bald eagle winter concentration areas in the cumulative effects analysis area. Committed conservation measures that prescribe nest avoidance would prevent effects to established nests and to eagle nests that may be established in the cumulative effects area. The 243 acres of known winter roosting habitat east of the Project Area would not be impacted by the Proposed Action or by CBM development within the bounds of the Southern Ute Reservation. Mitigation measures would be implemented to minimize or avoid impacts to any newly discovered winter roost areas as determined by surveys.

Other cumulative effects could result from activities on private lands, such as sand and gravel mining, ranching, agriculture, road construction, and rural and urban housing development. Approximately 86 percent of the bald eagle winter concentration areas in the Project Area are located on private lands, primarily along the river valleys where future development could be most intense. Effects on bald eagles in the form of nest disturbance or negative impacts to prey base from these activities would be in addition to the cumulative effects that have been quantified.

Table 3–204 Extent of Direct Cumulative Loss of MIS Habitats from Oil and Gas Development in Cumulative Effects Analysis Area

MIS Analyzed in Detail	Habitats Available (acres)	Habitats Affected by Alternative (acres)				
		1	2	5	6	7
Abert's squirrel	58,860	1,691	1,829	1,401	1,469	1,592
Bald eagle	27,500	820	863	802	802	820
Beaver	*	*	*	*	*	*
Black Bear	291,878	12,841	13,447	12,523	12,569	12,260
Deer Mouse	478,999	24,485	25,168	23,821	24,014	24,273
Elk	468,431	24,485	25,168	23,821	24,014	24,273
Green-tailed towhee	279,092	17,957	18,476	17,592	17,707	17,825
Hairy woodpecker	227,663	4,542	4,375	4,182	4,267	4,421
Mallard	*	*	*	*	*	*
Merriam's Turkey	440,800	20,425	21,030	19,904	20,052	20,238
Mexican Spotted Owl	57,980	-[a]	-[a]	-[a]	-[a]	-[a]
Mountain bluebird	415,931	9,049	9,398	8,808	8,873	8,949
Mule deer	468,430	20,085	19,996	19,771	20,706	19,838
Northern Goshawk	46,350	1,591	1,675	1,362	1,410	1,523
SW Willow Flycatcher	534	0	0	0	0	0

Note:

a. Acres affected under any of the alternatives are minor to non-existent and considered insignificant and discountable in effects. See individual species analysis in Appendices H and J.

b. * Quantitative values not available.

Table 3–205 Proportion of Cumulative Loss of MIS Habitats Available from Oil and Gas Development in Cumulative Effects Analysis Area

MIS	Habitats Available (percent)	Habitats Affected by Alternative (percent)				
		1	2	5	6	7
Abert's squirrel	11	2.9	3.1	2.4	2.5	2.7
Bald eagle	5	3.0	3.1	2.9	2.9	3.0
Beaver	*	*	*	*	*	*
Black Bear	51	2.3	2.4	2.2	2.2	2.3
Deer Mouse	88	5.1	5.2	5	5	5.1
Elk	86	5	5	5	5	5
Green-tailed towhee	66	6.4	6.6	6.3	6.3	6.4
Hairy woodpecker	42	2.0	2.1	1.8	1.9	1.9
Mallard	*	*	*	*	*	*
Merriam's Turkey	81	4.7	4.9	4.3	4.4	4.4
Mexican Spotted Owl	13[a]	<1	<1	<1	<1	<1
Mountain bluebird	76	2.2	22	2.1	2.1	2.1
Mule deer	86	4	4	4	4	4
Northern Goshawk	8	3.4	3.6	2.9	3.0	3.1
SW Willow Flycatcher	<1	0	0	0	0	0

Note:

a. The cumulative effects area for the spotted owl on the SUIT study area could only be loosely defined as mixed conifer and ponderosa pine. Data for the more refined definition of habitat as used for the Project Area is unavailable from the Tribe. See species analysis in Appendix H.

b. * Quantitative values not available.

3.19.13.2.2 Mexican Spotted Owl

Within the 547,600-acre cumulative effects area there are approximately 56,000 acres of mixed conifer and ponderosa pine that may provide foraging habitat for the MSO (BLM et al. 2002). Approximately 1,559 acres, or 2.8 percent, of this area would be impacted by oil and gas development on a cumulative basis. This level of habitat impact may affect but is not likely to adversely affect Mexican spotted owl.

Other impacts to MSO habitat could result from activities on private lands. These effects are not strictly quantifiable but there is little if any suitable MSO habitat on these other land ownerships.

3.19.13.2.3 Southwestern Willow Flycatcher

The Proposed Action would not impact SWWFs or their habitats in the Project Area. Committed conservation measures would prevent disturbance of habitats and restrict project activities from occurring in occupied habitats and during the breeding season. These measures include surveys to be completed within flycatcher habitat located within the development area prior to implementation. This is one of the committed conservation measures required and taken into consideration in determining no impact for the species.

Within the bounds of the SUIT Reservation, the SUIT EIS predicts that a maximum of 5.9 percent of the wooded riparian areas in the SUIT study area would be impacted (BLM et al. 2002). The impact of this disturbance on SWWF habitat is

unclear because these areas were not examined to assess their suitability for use by SWWFs. However, committed mitigation measures implemented by the SUIT restrict surface-disturbing activities during the breeding season if any SWWFs are located. These measures would minimize disturbance of SWWF habitat. Therefore, the primary impact to SWWFs from oil and gas development in the cumulative effects analysis area would be any loss of habitat that cannot be avoided on private land within the cumulative effects area. The extent of the impact is not currently quantifiable, but is expected to be a small portion of the available habitats.

Sand and gravel mining, livestock grazing, agriculture, road construction, and rural and urban housing development could also impact SWWF habitat. In the past, these activities have likely caused degradation or loss of substantial amounts of SWWF habitats (Marshall and Stoleson 2000) although no specific data are available for the cumulative effects analysis area. Considering the anticipated growth patterns, these activities are expected to continue into the future and may affect SWWFs because most of their habitats are on private lands, where there is little regulatory control.

3.19.13.2.4 Knowlton's Cactus

Within the cumulative effects area, 5,217 acres of suitable habitat for Knowlton's cactus have been impacted by CBM development, and an additional 3,655 acres of suitable habitat for Knowlton's cactus would be disturbed by oil and gas development within the cumulative effects area (BLM et al. 2002).

Since there are no known prior adverse effects to Knowlton's cactus within the cumulative effects analysis area resulting from past activities, and since there would be no adverse effects to Knowlton's cactus within the cumulative effects analysis area resulting from the Proposed Action or oil and gas development on Tribal lands, there would be minimal adverse cumulative effects to Knowlton's cactus. Impacts could occur on private land if prior surveys are not conducted.

Mitigation measures and pre-construction surveys designed to avoid effects to Knowlton's cactus from all project activities have been and would continue to be implemented and would minimize the potential for any adverse effects or cumulative adverse effects to this species.

3.19.13.2.5 Colorado Pikeminnow and Razorback Sucker

The analysis area for cumulative effects to the Colorado pikeminnow and razorback sucker includes the Project Area and the San Juan River watershed downstream of the Project Area to Lake Powell.

Approximately 846,000 acre-feet of water per year are annually depleted by a wide variety of current uses including domestic and irrigation consumption. Included in this total are 66 acre-feet per year that would be depleted by new CBM development in the SUIT EIS study area immediately south of the Northern Basin Project Area (BLM et al. 2002).

Although the depletions associated with the alternatives are small relative to total depletions within the basin, they would contribute to the overall cumulative ef-

fect of water depletions on both the Colorado pikeminnow and the razorback sucker.

Impacts to water quality caused by increased sediment loads, and the possibility of spills of fuels, lubricants, drilling fluids, or produced water, are not likely to have measurable effects on habitats of the endangered fishes. The probability of contaminating spills is low and best management practices would control sedimentation, which would be localized in impact. Given the distance between the Project Area and the occupied habitats, impacts would be minimal. Although it is reasonable to assume the CBM impacts would be minor, how these impacts might function in combination with the other cumulative effects to water quality, and how they might eventually influence habitats used by the pikeminnow and sucker, is uncertain.

3.19.13.3 Sensitive Species

Cumulative impacts for sensitive species are the result of past oil and gas development activities, and other activities primarily timber harvest, fire suppression, livestock grazing, and recreational use on federal lands, and development, ranching, recreation, timber harvest (minor) and agricultural activities on private and state lands. Cumulative habitat affected for FS sensitive species from past oil and gas activities, combined with the project alternatives and CBM development within the Southern Ute Reservation is presented on Table 3–206 and Table 3–207, and cumulative habitat affected for BLM sensitive species is presented on Table 3–208 and Table 3–209. A more detailed cumulative effects analysis is provided in Appendix I – the Biological Evaluation.

The above activities and their effects, when added together, have and would continue to affect wildlife habitat and species in the cumulative effects area. In most cases, the cumulative direct loss of habitat is minor, resulting in low to moderate impacts to the species. However, the actual impact to species is likely to be greater due to reduced habitat effectiveness associated with loss of habitat and increased human presence and disturbance in the area. Short-term cumulative impacts (10 years and less) to species include a minor amount of habitat loss affecting movement patterns, use of suitable habitat, and potential minor decreases in local population densities. Long-term cumulative impacts (greater than 10 years) are the same as short-term, with habitat loss potentially increasing incrementally depending on activities that occur and measures applied to reduce impacts. The greatest impact to species in the long-term would be reduced habitat effectiveness associated with human disturbances resulting from population increase and use of the area. Consequently, impacts to species would include continued effects to movement patterns, continued reductions in local population densities and, in the extreme, habitat displacement in localized areas.

Table 3–206 Cumulative Habitat Affected for FS Sensitive Species on NFS Lands in the Project Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects on NFS lands (acres)	Areal Extent of Effects by Alternative (acres)					Portion of Habitat Affected by Alternative (percent)				
			1	2	5	6	7	1	2	5	6	7
Northern leopard frog		X[1]	X	X	X	X	X	X	X	X	X	X
American peregrine falcon	3,224	37	89	128	44	73	88	2.76	3.97	1.36	2.26	2.72
American three-toed woodpecker	1,357	7	27	28	7	12	24	1.98	2.06	0.51	0.88	1.76
Brewer's sparrow	5,265	48	110	150	53	92	102	2.08	2.84	1.00	1.74	1.93
Ferruginous hawk	4,288	68	144	168	79	121	143	3.35	3.91	1.84	2.82	3.33
Flammulated owl	22,325	202	582	738	278	373	466	2.60	3.30	1.24	1.67	2.08
Lewis' woodpecker	28,125	203	617	893	277	372	460	2.19	3.17	0.98	1.32	1.63
Loggerhead shrike	5,265	48	110	150	53	92	102	2.08	2.84	1.00	1.74	1.93
Northern goshawk	11,447	201	426	451	241	309	359	3.72	3.93	2.10	2.69	3.13
Olive-sided flycatcher	11,102	87	250	386	125	155	203	2.25	3.47	1.12	1.39	1.82
Bluehead sucker		X	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker		X	X	X	X	X	X	X	X	X	X	X
Roundtail chub		X	X	X	X	X	X	X	X	X	X	X
Great Basin silverspot		X	X	X	X	X	X	X	X	X	X	X
Fringed myotis	32,657	257	667	1,031	314	431	534	2.04	3.15	0.96	1.31	1.63
Gunnison's prairie dog	937	14	18	13	13	13	>1	>1	>1	>1	>1	>1
Spotted bat	35,045	298	746	1,132	352	499	614	2.12	3.23	1.00	1.42	1.75
Townsend's big-eared bat	32,657	257	667	1,031	314	431	534	2.04	3.15	0.96	1.31	1.63

Note:
1. Northern leopard frog, bluehead sucker, flannelmouth sucker, bonytail chub and great basin silverspot habitat addressed qualitatively in Appendix I

Table 3–207 Cumulative Habitat Affected for FS Sensitive Species in the Cumulative Effects Analysis Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres)					Portion of Habitat Affected by Alternative (percent)				
			1	2	5	6	7	1	2	5	6	7
Northern leopard frog		X[1]	X	X	X	X	X	X	X	X	X	X
American peregrine falcon	31,686	2,507	2,649	2,689	2,525	2,557	2,631	8.36	8.48	7.96	8.06	8.30
American three-toed woodpecker	1,528	7	27	28	7	12	24	1.76	1.83	1.76	0.78	1.57
Brewer's sparrow	174,077	12,509	12,649	12,682	12,601	12,636	12,649	7.26	7.28	7.23	7.25	7.26
Ferruginous hawk	193,371	9,424	9,431	9,439	9,427	9,431	9,431	4.87	4.88	4.87	4.87	4.87
Flammulated owl	63,932	1,310	1,770	1,917	1,411	1,481	1,654	2.76	2.99	2.20	2.31	2.58
Lewis' woodpecker	86,213	1,824	2,369	2,674	1,931	2,004	2,149	2.74	3.10	2.23	2.32	2.49
Loggerhead shrike	174,077	12,509	12,649	12,682	12,601	12,636	12,649	7.26	7.28	7.23	7.25	7.26
Northern goshawk	46,250	1,308	1,591	1,675	1,362	1,410	1523	3.44	3.62	2.94	3.04	3.29
Olive-sided flycatcher	31,410	647	856	923	697	733	792	2.72	2.93	2.21	2.33	2.52
Bluehead sucker	X	X	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker	X	X	X	X	X	X	X	X	X	X	X	X
Roundtail chub	X	X	X	X	X	X	X	X	X	X	X	X
Great Basin silverspot	X	X	X	X	X	X	X	X	X	X	X	X
Fringed myotis	427,231	20,755	21,165	21,529	20,812	20,929	21,032	4.95	5.03	4.87	4.89	4.92
Gunnison's prairie dog	937	14	18	13	13	13	>1	>1	>1	>1	>1	>1
Spotted bat	446,560	23,327	23,775	24,161	23,381	23,528	23,643	5.32	5.41	5.23	5.26	5.29
Townsend's big-eared bat	427,231	20,755	21,165	21,529	20,812	20,929	21,032	4.95	5.03	4.87	4.89	4.92

Note:
1. Northern leopard frog, bluehead sucker, flannelmouth sucker, bonytail chub and great basin silverspot habitat addressed qualitatively in Appendix I

Table 3–208 Cumulative Habitat Affected for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals) in the Project Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres)					Portion of Habitat Affected by Alternative (percent)				
			1	2	5	6	7	1	2	5	6	7
American peregrine falcon	2,358	22	33	37	22	32	33	1.39	1.56	0.93	1.35	1.39
Ferruginous hawk	1,354	10	17	25	13	17	17	1.25	1.84	0.96	1.25	1.25
Northern goshawk	2,776	3	11	19	3	10	11	0.39	0.68	0.10	0.36	0.39
Bluehead sucker		X[1]	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker		X	X	X	X	X	X	X	X	X	X	X
Roundtail chub		X	X	X	X	X	X	X	X	X	X	X
Allen's big-eared bat	14,245	69	132	189	69	129	132	0.92	1.32	0.48	0.90	0.92
Big free-tailed bat	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Fringed myotis	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Spotted bat	14,969	76	139	205	99	135	139	0.92	1.36	0.66	0.90	0.92
Townsend's big-eared bat	14,388	69	131	189	92	126	131	0.91	1.31	0.63	0.87	0.91
Yuma myotis	10,083	59	105	153	59	103	105	1.04	1.51	0.58	1.02	1.04

Note: bluehead sucker, flannelmouth sucker, and roundtail chub habitat addressed qualitatively in Appendix I

Table 3–209 Cumulative Habitat Affected for BLM Sensitive Species on all Lands with BLM Jurisdiction (includes BLM Surface/federal Minerals and Private Surface/federal Minerals) in the Cumulative Effects Analysis Area

Species	Areal Extent of Habitat in the CEAA (acres)	Existing oil and gas effects in CEAA (acres)	Areal Extent of Effects by Alternative (acres) 1	2	5	6	7	Portion of Habitat Affected by Alternative (percent) 1	2	5	6	7
American peregrine falcon	31,686	2,507	2,518	2,522	2,507	2,517	2,518	7.94	7.95	7.91	7.94	7.94
Ferruginous hawk	193,371	9,424	9,431	9,439	9,427	9,431	9,431	4.87	4.88	4.87	4.87	4.87
Northern goshawk	46,250	1,308	1,316	1,324	1,308	1,315	1,316	2.84	2.86	2.82	2.84	2.84
Bluehead sucker		X[1]	X	X	X	X	X	X	X	X	X	X
Flannelmouth sucker		X	X	X	X	X	X	X	X	X	X	X
Roundtail chub		X	X	X	X	X	X	X	X	X	X	X
Allen's big-eared bat	442,613	20,139	20,202	20,259	20,139	20,199	20,202	4.56	4.57	4.55	4.56	4.56
Big free-tailed bat	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Fringed myotis	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Spotted bat	462,238	23,599	23,662	23,728	23,622	23,658	23,662	5.11	5.13	5.11	5.11	5.11
Townsend's big-eared bat	442,909	21,027	21,089	21,147	21,050	21,084	21,089	4.76	4.77	4.75	4.76	4.76
Yuma myotis	378,734	18,766	18,812	18,860	18,766	18,810	18,812	4.96	4.97	4.95	4.96	4.96

Note: bluehead sucker, flannelmouth sucker and roundtail chub habitat addressed qualitatively in Appendix I

3.19.13.4 Migratory Birds

CBM development can fragment habitat for migratory birds. Most studies of habitat fragmentation have been conducted primarily in eastern and mid-western landscapes (Faaborg et al. 1998) that are comprised primarily of naturally large contiguous tracks of densely forested habitats inhabited by bird communities adapted to large contiguous blocks of habitat. Forested habitats in the Rocky Mountains are naturally much more fragmented than eastern or mid-western forests by steeper terrain, much greater variation in altitude, aspect and exposure, naturally integrated grasslands, and other geographic factors. For this reason, it is unknown whether the fragmentation effects found in these eastern and mid-western studies are applicable to bird communities adapted to the naturally highly fragmented landscapes of the Rocky Mountains and the Project Area. Therefore, it cannot be determined with certainty whether or not additional minor fragmentation associated with CBM development would cause declines in species richness or other classic fragmentation effects. The small forest openings created by well sites and road and pipeline corridors would resemble the many openings that naturally occur throughout the Project Area and thus are unlikely to alter habitat quality for migratory birds in any detectable way. Alternative 2 in combination with CBM development within the bounds of the SUIT Reservation would crate the greatest number of openings and potential for habitat fragmentation, followed by Alternatives 1, 7, 6, and 5.

Other factors that affect habitat capability for migratory birds include timber harvest, forest restoration, fuels reduction and fire suppression, grazing, road building, agricultural development, rural development, and recreation. Cumulatively, these activities have altered the amount, distribution, and suitability (both positive and negative) of habitat for migratory birds. For example, timber harvest over the past 60 years has converted about 1,500 acres of ponderosa pine forest on Federal land within the Project Area to other vegetation types, primarily

Gambel oak, resulting in a net increase in available habitat for the mountain shrub analysis group. Together, historic fire suppression and timber harvest activities have changed the structure of ponderosa pine stands and increased the amount and density of Gambel oak and other shrub species throughout the Project Area.

Fire suppression has changed the structure of ponderosa pine and pinyon-juniper woodlands over the past 100 years and restoring the role of fire is a recommended management action for improving migratory bird habitat in western ponderosa pine forests (Rich et al 2004). In general, fire suppression has increased the density of pine stands in the Project Area. Pine stands have become more densely stocked with smaller diameter trees, have more uniform stand structures and more closed canopies than prior to European settlement (FS 2004c). Increased pine stand densities have resulted in greater mortality of small diameter trees, providing increased foraging opportunities for woodpeckers in the primary cavity excavator analysis group, but the reduction in trees in the largest diameter classes (< 16 inches d.b.h.) has reduced the availability of their preferred nesting substrate. Populations of some cavity excavator species fluctuate in response to insect infestations particularly after stand-replacement fire (Andrews and Righter 1992) and therefore fire suppression has removed an important source of seasonally abundant food.

On non-Federal lands adjacent to the Project Area, past agricultural practices, increasing residential development and associated fire suppression activities have probably caused an expansion in mountain shrub, piñon-juniper and grassland habitats, benefiting birds of conservation concern in those analysis groups. Residential development is expected to continue in the cumulative effects area for the foreseeable future. Fuel reduction and wildfire mitigation, grazing, oil and gas development, and urban development activities are likely to continue altering the amount and condition of migratory bird habitat in the cumulative effects area. However, unless the scope of these activities changes significantly in the future, these activities are not likely to change the overall distribution of migratory bird habitats across the area.

3.19.14 Cultural Resource Impacts

The Advisory Council on Historic Preservation regulations implementing Section 106 of the National Historic Preservation Act (36 CFR 800) include a definition of adverse effect with respect to cumulative effects on significant historic properties. Adverse effects include reasonably foreseeable effects caused by the preferred alternative that would occur later in time, that would be farther removed in distance, or that would be cumulative (36 CFR 800.5). A determination of no adverse effect means that there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for the National Register.

All federal undertakings will be subject to Section 106 review. Based on the proportion of known sites that are listed on or considered eligible for the National Register, about 30 percent of the cultural resource sites that may be affected would be historic properties. The potential adverse effects to these properties cannot be derived from the database or existing records, but must be identified in

the field. Plus, additional work will be required on some historic properties after the initial inventory to complete National Register evaluations and to confirm their boundaries.

When other large-scale projects in the region with the potential to impact cultural resource sites, traditional cultural properties, and area of traditional use, such as the Tiffany Enhanced Coalbed Methane Recovery Project, the TransColorado Gas Pipeline Project, the Animas-La Plata Project, and improvements to State Road 550 and U.S. Highway 160, are taken into consideration, the cumulative number of known and as yet undiscovered cultural resource sites that may be affected could approach 1,000 (BLM 1996; Reed at al. 1992; Chenault 1996). An uncounted number of cultural resource sites were undoubtedly lost to development prior to regulatory protection in the 1970s. Assuming that 30 percent of the known sites may be historic properties, there is the potential for 600 significant cultural resource sites, traditional cultural properties, and areas of traditional use to experience adverse effects.

In oil and gas development, avoidance and protection are the preferred mitigation measures for historic properties, and it will be feasible to avoid and protect the majority of historic properties. Well field development also would improve access to the vicinity of some historic properties, increase traffic, and activities near cultural resource sites, and increase the potential for inadvertent effects from unrelated activities. The combination of past, present, and reasonably foreseeable oil and gas leasing, other recent and planned projects in the region, plus the increase in the number of visitors to the area, will incrementally increase the cumulative effects to historic properties.

3.19.15 Land Use Impacts

The areal extent of land displaced by existing and proposed oil and gas development within the Project Area for each land use category is shown in Table 3–210.

Under Alternative 1, the cumulative effects of CBM development within La Plata and Archuleta Counties, including the SUIT Reservation, would include total displacement of existing land uses from 3,700 acres for CBM facilities for the life of the project. Land use conflicts between CBM development and residential growth would be amplified over the cumulative effects area. However, large-scale changes to growth patterns are not likely to result from the proposed CBM development. In La Plata County, an increase in residential construction and urban growth is expected to occur along with an increase in the number of gas wells (La Plata County 2002b). Archuleta County would experience a similar response to CBM development.

Under the action alternatives there would be little adverse impact to the forage resources. Re-seeded disturbed areas could actually produce more forage than before disturbance. Livestock distribution could actually improve due to better access using reclaimed roads. Should this occur, there could be less overall grazing pressure on key areas such as riparian bottoms. Therefore, forage conditions on key areas should continue to meet or exceed standards contained in land management plans.

Table 3–210 Cumulative Displacement of Land for Oil and Gas Facilities, by Land Use Category and Alternative

Land Use Category	Existing Oil and Gas Facilities in Project Area (acres)	SUIT FEIS Preferred Alternative[1] (acres)	Cumulative Land Displacement for Oil and Gas Facilities by Alternative[2] (acres)				
			1	2	5	6	7
Agriculture/Rangeland[3]	267	1,082	1,424	1,500	1,432	1,434	1434
Undeveloped	204	1,310	2,028	2,445	1,63	1,749	1,858
Residential	80	68	209	258	216	204	204
Urban and Roads	2	10	19	19	17	19	19
Total[4]	553	2,470	3,680	4,222	3,268	3,406	3,515

Notes:
1. Most of the land displacement associated with the SUIT FEIS Preferred Alternative is within La Plata County.
2. Cumulative is the sum of long-term land displacement for existing oil and gas facilities, SUIT FEIS Preferred Alternative, and the proposed CBM facilities for each alternative.
3. The agriculture/rangeland category includes farmland.
4. Totals may not match precisely with values obtained by adding unit numbers because of rounding conventions.

With or without additional CBM development, the current trends in development in La Plata County suggest that future urban growth would be primarily concentrated in the areas southeast of the City of Durango near the intersection of U.S. Highway 550 and U.S. Highway 160 and around the Town of Bayfield. CBM development should not alter this growth pattern. Currently, no major industrial projects, such as power plants or manufacturing facilities, are planned in La Plata County (BLM et al. 2002). The current trends in development for Archuleta County indicate no future urban areas within the Project Area.

3.19.16 Recreation Impacts

A review of the SUIT final EIS for Oil and Gas Development (BLM et al. 2002) indicated that no measurable impacts on recreational resources are expected from construction and operation of wells and associated facilities. There are no predicted effects on recreational opportunities from other reasonably foreseeable oil and gas development in the SUIT study area. Significant portions of the SUIT Study Area are closed to the public by the SUIT or are made available to the public through purchase of a Tribal permit.

Cumulative CBM development in the Project Area consists of existing CBM facilities and the facilities proposed for each alternative. Existing and proposed CBM facilities that affect developed recreational facilities are within visual or audible distance from the recreational facilities. The additive visual impact of proposed well development in the Project Area and the SUIT EIS study area would result in increased degradation of the scenic resource within the cumulative-impacts area. Ongoing CBM development and other land development that occurs with increasing population growth would result in an overall degradation of the natural character and opportunities for solitude that draw many recreationists to the region.

3.19.17 Transportation Impacts

Relatively small levels of direct effects to the primary access routes within the Project Area, including State, National Forest, and county roads, would occur as a result of project-related vehicular traffic associated the alternatives. Continued CBM development in the Project Area is not expected to significantly impact traffic congestion or accident rates. Traffic rates on county roads that would be most heavily used by gas industry vehicles are expected to increase between 50 and 137 percent between 1998 and 2020, primarily as a result of residential growth on private land in the Project Area. Oil and gas development would contribute to increased traffic on these roads to a much lesser degree than would population growth.

South of the Project Area, the SUIT analysis found that CBM development within the bounds of the SUIT Reservation would not generate additional traffic in the Project Area. CBM traffic in the SUIT study area would not use any of the county roads and highways that would be used under any alternative in the Northern San Juan Basin Project Area. Therefore, there would be no incremental effects to traffic congestion and accident rates from cumulative oil and gas development on individual county roads and highways within the Project Area from SUIT CBM traffic. Cumulative effects would occur primarily from existing and projected traffic within the Project Area.

The greatest increases in traffic volume from cumulative (existing and anticipated) CBM construction and maintenance traffic would occur on segments of CRs 223, 228, 501, 502, 504, 505, and 527, and U.S. Highway 550. With the exception of CR 527, these roads are the same roads used to access existing and future residential development. A significant impact on the volume of traffic would exist if anticipated CBM development were projected to generate 25 percent or more additional daily vehicle trips. Table 3-134 (Transportation Section of this chapter) summarizes daily trips associated with existing and projected CBM wells under Alternative 1 in the Project Area, and compares the trips with the ADT volume of all vehicle types for 1998 and the projected 2020 ADT for selected roads in La Plata County. The table shows that increases generated by cumulative CBM maintenance traffic are generally less than one-percent, and in one case, 10 percent of additional average daily trips on most of the selected segments of county roads.

The cumulative CBM industry traffic effects would include an increased risk of traffic accidents in proportion to the amount of increased daily traffic for any of the alternatives. The number of traffic accidents has increased on some county roads in areas of existing CBM development. The potential for conflicts with CBM-related traffic is highest along roads used to access existing and future residential development. Two of these roads (CRs 228 and 501) were identified as high accident locations. However, rates of traffic accidents would increase because of an increase in the volume of traffic, which is not expected to be significant. The cumulative transportation effects of traffic congestion and accident rates would not be significant for any roadways in the Project Area and would have no perceivable impact on any roadways, with the exception of CR 223, which would experience an increase in daily traffic levels of about 16 percent at

the beginning of production activities and about ten-percent over time. These results apply to all alternatives.

Increased degradation of existing roadways may result from any of the alternatives when incremental effects of proposed CBM traffic are added to existing CBM and other traffic. Based on the distribution of the well locations for each alternative, additional wear and tear on county roads and classified open FS roads would likely occur. CBM industry contribution to wear and tear to county and NFS roads would probably be greater than the proportional use described in Table 3-131 because use of medium and heavy trucks by the CBM industry is probably proportionally higher than current heavy truck use of the selected county roads.

Table 3–211 summarizes the cumulative number of CBM access road miles from existing and projected CBM development in the Project Area. The SUIT analysis did not evaluate the increase in the number of access road miles; therefore, the cumulative access road miles shown in Table 3–211 include only cumulative access road miles from CBM development within the Project Area. There would be no increase in the miles of road open to the public on federal, state, and private lands, as all proposed access roads would be closed under the alternatives.

Table 3–211 Cumulative Access Roads for Each Alternative

	Total Length by Alternative (miles)				
Roads	1	2	5	6	7
Existing	191	191	191	191	191
Alternative	118	202	43	66	92
Cumulative	309	393	234	257	283
Increase	62%	107%	23%	34%	48%

3.19.18 Visual Resource Impacts

The cumulative-impacts analysis includes: (1) existing conventional and CBM wells in the SUIT Project Area; (2) conventional and CBM wells projected and approved in the SUIT EIS; and (3) existing and proposed wells and ancillary facilities for each proposed development alternative within the Project Area.

When the existing and proposed oil and gas development are considered together, overall disturbance would increase from 50 to 236 percent from existing development for the alternatives (Table 3–212). Most of this total disturbance would occur in areas classified with the Retention VQO under each alternative. Disturbance in areas classified with Partial Retention VQO and Modification VQO would account for the remainder of disturbance from project facilities and roads.

Table 3–212 Distribution of Existing and Proposed Oil and Gas Development Disturbance in the Project Area by Visual Quality Objective

Visual Quality Objective	Disturbance[1] by Alternative 1 (acres)	2 (acres)	5 (acres)	6 (acres)	7 (acres)
Retention	562	738	497	511	597
Partial Retention	327	581	167	419	484
Modification	272	329	71	314	520
Total	1,162	1,649	735	1,244	1,601
Increase over existing	137%	236%	50%	31%	69%

Note:
1. Includes all wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, State, and private lands
2. Does not include one compressor and one injection well totaling 3.5 acres of disturbance located outside of the Project Area boundary. These facilities are not within the area inventoried with VQO classes.

None of the SUIT EIS study area was inventoried or analyzed with the FS VMS system. Therefore, the cumulative acres presented in Table 3–213 include the number of acres within each distance zone as viewed from the primary sensitive viewpoints of residences, roads, and recreational areas. The cumulative disturbance acres were presented in this format in the SUIT FEIS. The long-term disturbance from oil and gas development is shown for the SUIT project and from existing development in the second and third columns of the table. The columns under the heading Disturbance by Alternative show the cumulative long-term disturbance from the SUIT acres, existing disturbance in the Project Area, and projected disturbance from each alternative. Alternative 2 would account for the largest amount of disturbance in the foreground distance zones. The SUIT acres account for the majority of cumulative disturbance under any of the alternatives.

Table 3–213 Distribution of Cumulative Oil and Gas Development Disturbance by Distance Zone

Sensitive Viewing Area/Distance Zone	SUIT Cumulative (acres)	Existing (acres)	Disturbance[1] by Alternative 1 (acres)	2 (acres)	5 (acres)	6 (acres)	7 (acres)
Residences							
Foreground	4,853	169	5,134	5,176	5,118	5,135	5.135
Middle ground	5,194	124	5,439	5,655	5,390	5,431	5,432
Background	12,976	23	13,438	13,667	13,077	13,194	13,312
Roads							
Foreground	2,243	105	2,455	2,530	2,407	2,474	2,470
Middle ground	3,596	199	4,245	4,629	3,950	4,041	4,140
Background	17,235	12	17,361	17,390	17,278	17,297	17,319
Recreation							
Foreground	225	54	592	816	321	391	464
Middle ground	242	140	638	862	569	590	625
Background	19,222	123	19,447	19,485	19,426	19,425	19,439

Note:
3. Includes all existing and proposed wells, pads, roads, pipelines, disposal wells, and compressors on NFS, BLM, state, and private land in the Project Area, and all cumulative tribal and non-tribal disturbance acreage within the SUIT Study Area.
4. Disturbance acres from residential road and recreation viewing areas overlap; therefore, the areas do not add up to disturbance area totals presented in Chapter 2.

Another trend that will increase visual-quality impacts and conflicts is projected growth in La Plata County. It is anticipated that growth will occur along U.S. 160 and near many of the county roads north of U.S. 160. As residential development increases, CBM well operators will be further challenged to meet the criteria for the Partial Retention and Retention VQOs. The number of mitigation measures that can be applied to each well is limited. Furthermore, in some instances, viewers (primarily permanent residents on private land) will be affected by CBM development regardless of the level of mitigation involved.

3.19.19 Noise Impacts

The prominent sources of noise in and next to the Project Area are widespread oil and gas development; traffic, especially on Highway 160, residential areas, and occasional airplane traffic at the La Plata County Airport south of the Project Area. Additional noise sources in the Project Area are expected to occur with commercial and industrial development along Highway 160 east of the Florida River and near Bayfield.

Noise generated by CBM development activities within the boundary of the Southern Ute Reservation does not interact cumulatively with noise sources within the Project Area. Rather, the noise effect of individual CBM facilities is localized. Furthermore, because wells and compressor stations would be separated by sufficient distance, the cumulative effect of numerous facilities in a specific area would be limited. Compressor stations would have the highest potential to increase general localized noise if located near other existing and future sources of noise. The pump jacks at each well pad would not produce sufficient noise to interact significantly with other sources to raise the overall noise within a localized area.

The CBM compressor stations may contribute to a slight cumulative increase in noise in the Project Area. Under all alternatives, two compressor stations would be constructed near the proposed industrial and commercial development along Highway 160 east of the Florida River. The compressor stations and the industrial and commercial development would likely result in slightly higher overall noise in this area. Under all alternatives, two or three compressor stations would be constructed northeast of Bayfield near existing and proposed residential developments. The combination of increased residential activity and additional compressor stations would increase noise levels slightly here and increase the potential for noise conflict with residences.

Because no compressor stations are proposed for the Bayfield area, overall noise is not expected to increase significantly on a cumulative basis. All other compressor stations would be constructed at sufficient distances from existing and proposed noise sources so as not add significantly to the overall noise levels.

3.19.20 Social and Economic Impacts

To analyze cumulative effects on social and economic values, the potential effects of CBM development in the NSJB was estimated by calculating the sum of

the socioeconomic effects of the following past, present, and reasonably foreseeable actions.

- The existing oil and gas development in the Project Area.
- The Preferred Alternative of the Final Environmental Impact Statement for Oil and Gas Development on the Southern Ute Indian Reservation (BLM et al. 2002).
- The alternatives considered for the proposed project.

With or without additional CBM development, the populations of both counties in the Project Area are expected to increase over the life of the proposed project. Therefore, additional socioeconomic effects are likely to occur because of this anticipated community expansion. The current trends in development indicate that population, employment, housing, local facilities, services and infrastructure, and total county revenues would increase over the life of the project, with or without additional CBM development in both La Plata and Archuleta Counties.

3.19.20.1 Population

Under Alternative 1, the cumulative change in population that would result from employment in the oil and gas sector would represent an increase of less than 3 percent, compared with the total in the region. Therefore, there would be a small increase in population, and little or no effect on the demographics of La Plata and Archuleta Counties or the NSJB region.

However, the populations in both La Plata and Archuleta Counties are expected to continue to increase, with or without additional CBM development. Between 1990 and 1999, the population of unincorporated La Plata County increased by about 54 percent. The population in Archuleta County increased by more than 25 percent between 1993 and 1998 (BBC 2002). The population in the region is also projected to increase over the life of the project.

Under Alternative 2, the cumulative employment would be larger, compared with the other alternatives. The cumulative employment would represent an increase in population of less than 4 percent, however, compared with the total population of both La Plata and Archuleta Counties. In addition, the majority of the project workers would come from the NSJB region. Therefore, the cumulative effects on the population and demographics for Alternative 2 would be similar to those of Alternative 1.

The cumulative effects on population and demographics for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.19.20.2 Employment

Under Alternative 1, the cumulative employment in the oil and gas sector would represent an increase of 3 percent, compared with the total employment in the region. In addition, the regional economy is well diversified. The cumulative employment in the oil and gas sector would represent a small increase in total employment in La Plata or Archuleta Counties or the NSJB region.

The cumulative effects on total employment in the region for Alternative 5 would be the same as those for Alternative 1. The cumulative employment in the oil and gas sector would be greater for Alternative 2 compared with the other alternatives. The cumulative employment for Alternative 2 would represent less than 4 percent of the total employment in the region. Therefore, there would be a small increase in the total employment in the two counties of the NSJB region and the cumulative effects would be similar to those of Alternative 1.

The cumulative effects on total employment in the region for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.19.20.3 Earnings and Income

Under Alternative 1, the cumulative number of jobs in the oil and gas sector would be small compared with total employment and income in the region. Therefore, there would be a small increase in earnings or per capita income in La Plata or Archuleta Counties or the region. The cumulative effects on earning and income for Alternatives 2, 5, 6, and 7 would be similar to those of Alternative 1.

3.19.20.4 Housing

For any of the alternatives, the cumulative number of new residents who would require housing would be small. Therefore, there would be a small increase in demand on the local housing market and little or no effect on the availability of housing in La Plata or Archuleta Counties or the NSJB region.

3.19.20.5 County Facilities, Services, and Infrastructure

For any of the alternatives, the cumulative employment for CBM development would result in a small number of new residents compared with the total population of the two counties. There would be a small increase in demand for county facilities, services, and infrastructure because there would be few additional residents as a result of the project. However, the populations in both La Plata and Archuleta Counties are projected to increase, even without additional CBM development. Therefore, there may be impacts on county facilities, services, or infrastructure from population increases that are unrelated to CBM development.

3.19.20.6 Fiscal Conditions of Local Government

The cumulative revenues associated with Alternative 1 would generate substantial additional revenues for both La Plata and Archuleta Counties. *Ad valorem* property taxes would be the primary direct source of increased revenues for both La Plata and Archuleta Counties. Cumulatively, Alternative 1 would increase annual property tax revenues to La Plata County by $1.3 million, compared with current revenues. Cumulatively, Archuleta County annual property tax revenues would increase by $600,000, compared with current revenues.

The new CBM wells associated with Alternative 1 would generate little or no revenues for the SUIT. However, assuming a constant gas price ($2/mcf) over the life of the project, the cumulative CBM wells in the NSJB would generate an estimated total of $118 million (1997 dollars) in revenues to Colorado tribes over

the life of the project (BLM et al. 2002). The cumulative royalties to the SUIT from CBM development on tribal land would generate an average of $5.9 million per year (1997 dollars and constant gas price) (BLM et al. 2002).

Cumulatively, Alternative 2 would increase annual property tax revenues to La Plata County by $2.9 million compared with the current level. Annual property tax revenues to Archuleta County would increase by $800,000 compared with the current level. The cumulative revenues to the SUIT would be the same as for Alternative 1.

The cumulative effect of Alternative 5, if additional federal wells are not allowed, would be a loss of additional revenues to both counties compared with the various action alternatives. Cumulatively, annual property tax revenues to La Plata County would increase by $0.9 million compared with current revenues. Annual property tax revenues in Archuleta County would increase by almost $70,000, compared with current revenues. The cumulative revenues to the SUIT would be the same as those of Alternative 1.

The cumulative effects on county revenues for Alternatives 6 and 7 would be similar to those of Alternative 1.

3.19.20.7 Impacts from Eventual Decline in Gas Revenues and Boom-and-Bust Cycle

Under Alternative 1, the cumulative effects of oil and gas development would affect county revenues moderately at the end of the project. As of the year 2000, revenues for the existing oil and gas production in La Plata County were considered to be at an all-time high (La Plata County 2002a). As the production rates for the cumulative CBM wells in the La Plata County decrease, production-related revenues would decline over time, with or without additional CBM development. The total revenues for both counties are projected to increase over time, however, regardless of the decline in production-related revenues. Overall, county revenues from property taxes are expected to increase over time. It is likely that the reduced property tax revenues that would result from the end of the project would be somewhat offset by increased total assessed valuation in La Plata County, from additional residential and commercial development. Additional sources of revenue may be required, however.

The cumulative effects on county revenues and the potential for a boom-and-bust cycle for Alternatives 2, 5, 6, and 7 would be similar to those of Alternative 1.

3.19.20.8 County Expenditures

Under Alternative 1, the cumulative oil and gas development would have a moderate effect on county expenditures, but these costs would be greatly offset by the additional county revenues from gas production. County expenditures are likely to increase with or without additional CBM development. The populations in both La Plata and Archuleta Counties have increased at a high rate over recent years and are projected to continue to grow. Therefore, there may be impacts on county expenditures because of general increases in population that are unrelated to CBM development.

Under Alternatives 2, 5, 6, and 7 the cumulative effects on county expenditures would be the same as those of Alternative 1.

3.19.21 Health and Safety

The analysis of cumulative human health and safety effects considers the existing and proposed development in the project plus the existing level of development approved in the SUIT FEIS (BLM et al. 2002).

3.19.21.1 Underground Coal Fires

Under Alternative 1, the risk of underground coal fires from cumulative existing and new gas wells would be moderate and long-term; however, coal fires are unlikely to pose a risk to human health and safety.

The effects on human health and safety as a result of underground coal fires associated with the cumulative CBM development under Alternatives 2 and 7 are similar to those for Alternative 1. For Alternatives 5 and 6, a smaller cumulative number of CBM wells and associated facilities would be installed in the Project Area compared with the other alternatives; the effects on human health and safety associated with underground coal fires would be similar, however, to those of Alternative 1.

3.19.22 Air Quality Impacts

Air pollutant dispersion modeling was performed to quantify potential CO and NO_2 impacts during operation, based on the period of maximum potential emissions and other emission sources located within the Analysis Area (including tribal, Colorado, and New Mexico reasonably foreseeable sources.) Operation emissions would occur due to natural gas-fired separator and dehydrator heaters, small well-head engines, and increased pipeline compression requirements. Since produced natural gas is nearly pure methane and ethane, with little or no liquid hydrocarbons, no significant direct SO_2, or reactive VOC emissions would occur.

In addition, since the maximum direct modeled CO impacts (nearly 1,218 $\mu g/m^3$ (1-hour) and 431 $\mu g/m^3$ (8-hour) for Alternative 2 — Maximum Development) were below the EPA modeling guideline significance levels of 2,000 $\mu g/m^3$ (1-hour) and 500 $\mu g/m^3$ (8-hour), cumulative CO impacts were assumed not to be significant. Based on this analysis, it is assumed the cumulative effect of CO impacts from the proposed action and alternatives (plus other existing and reasonable foreseeable sources, and representative background concentrations) would not exceed applicable air quality standards.

Potential maximum annual cumulative NO_2 concentrations, under Alternatives 1, 2, and 5, were predicted to be 93.0 $\mu g/m^3$, 93.2 $\mu g/m^3$, and 92.8 $\mu g/m^3$, respectively; close to, but not exceeding the annual NO_2 NAAQS of 100 $\mu g/m^3$. Since the reasonably foreseeable NO_x emissions are dominated by existing and reasonably foreseeable sources (the proposed action and alternative sources account for nearly one percent of the total impact), the predicted maximum cumulative NO_2 concentrations are nearly the same among all Alternatives.

Potential maximum cumulative NO_2 concentrations, atmospheric deposition (acid rain) and visibility impacts to the Mesa Verde National Park and Weminuche Wilderness PSD Class I areas are presented in Table 3–214. Most of the predicted impacts are below significance thresholds. The NPS and the FS consider potential visibility impacts within their mandatory federal PSD Class I areas greater than a 1.0 deciview "just noticeable change" from cumulative air pollutant emission sources to be an adverse impact. Given the "reasonable, but conservative" assumptions incorporated into the visibility impact analysis, the cumulative impacts are likely to be less than those presented in Table 3–214, although the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 0 to 10 days per year at Mesa Verde National Park, and between 1 to 18 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas.

Table 3–214 Maximum Potential Cumulative Air Quality Impacts by Management Alternative (including reasonably foreseeable Colorado, New Mexico and SUIT emission sources without Farmington RMP sources)

PSD Class I Area	Pollutant	Units	Alternative 1	Alternative 2	Alternative 5	Impact Threshold
Mesa Verde	Nitrogen Dioxide	Annual (μg/m³)	0.25	0.26	0.24	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.10	0.10	0.09	3
	Visibility	Greater than 1.0 deciview (days/year)	2 to 10	3 to 10	0 to 9	More than 1 day/year
Weminuche	Nitrogen Dioxide	Annual (μg/m³)	0.18	0.24	0.12	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.07	0.11	0.07	3
	Upper Grizzly Lake Chemistry[1]	ANC Change (percent)	3.4	3.9	2.9	10
		ANC Change (μeq/L)	0.8	0.9	0.7	1.0
	Visibility	Greater than 1.0 deciview (days/year)	1 to 13	5 to 18	1 to 9	More than 1 day/year

Note:
1. Potential cumulative impacts at other sensitive lakes would be less.
Source: RTP Environmental 2004

In addition to the cumulative air pollutant emission sources described above (including the proposed action and alternative sources, as well as other reasonably foreseeable emission sources located in Colorado, New Mexico, and on SUIT lands), the BLM recently initiated the process by which future natural gas development could occur under the jurisdiction of the Farmington, New Mexico, Field Office (BLM 2003a). Although the ROD (BLM 2003b) does not approve development of any additional individual wells (future NEPA analyses will be required prior to approving specific development), a "reasonable, but conservative" assessment of the possible air quality impacts from potential additional development in New Mexico was performed under this EIS.

The Farmington Proposed RMP included nearly 5,000 natural gas-fired wellhead engines (operating at a 9.6 g/HP-hour NO_x emission rate) and 360,000 HP of additional natural gas-fired pipeline compression (operating at a 1.5 g/HP-hour

NO_x emission rate). These potential emission sources were analyzed based on the following modeling assumptions:

- maximum projected development which could occur at the end of the LOP.
- wells would be fully operational (no dry holes), operate continually at maximum production rates, and remain operating (no "shut ins") throughout the LOP.
- gas-fired well-head engines would operate continually at their maximum design throughout the LOP.

In practice, well development equipment would be phased in gradually, and added or removed incrementally as actual development requirements change. These assumptions are made because the Farmington RMP does not authorize specific natural gas development; the assumptions reflect a "reasonable, but conservative" upper bound on potential air pollutant emissions and their predicted air quality impacts.

The maximum predicted cumulative NO_2 concentrations, atmospheric deposition, and visibility impacts (including the Farmington RMP and Alternative 1, 2, and 5 emission sources) are presented in Table 3–215. Although most of the predicted impacts are below significance thresholds, because the background ANC level at Upper Grizzly Lake is less than 25 μeq/L, the FS 1.0 μeq/L "Limit of Acceptable Change" is applicable. Therefore, based on "reasonable, but conservative" analysis assumptions, this threshold would be exceeded by the predicted impacts of 1.9 to 2.1 μeq/L. In addition, the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 34 to 62 days per year at the Mesa Verde National Park, and between 15 to 47 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas.

Further analysis was conducted to evaluate the potential effectiveness of more effective emission controls on Farmington RMP natural gas-fired well-head engines operating at a 2.0 g/HP-hour NO_x emission rate. Although control equipment is available at this emission rate, the costs of such controls are higher and their performance throughout a 20 year LOP has not been evaluated. Potential maximum cumulative NO_2 concentrations, atmospheric deposition, and visibility impacts (including the Alternative 1, 2, and 5 emission sources) are presented in Table 3–215. Although most of the predicted impacts are below significance thresholds, because the background ANC level at Upper Grizzly Lake is less than 25 μeq/L, the FS 1.0 μeq/L "Limit of Acceptable Change" is applicable. Therefore, based on "reasonable, but conservative" analysis assumptions, this threshold would be exceeded by the predicted impacts of 1.1 to 1.4 μeq/L. In addition, the NPS and FS visibility "Limit of Acceptable Change" of more than a single day above a 'just noticeable change' (FLAG 2000) could be exceeded between 9 to 35 days per year at Mesa Verde National Park, and between 7 to 31 days per year at the Weminuche Wilderness PSD mandatory federal Class I areas. Finally, small well-head engines with NO_x emission controls less than 2.0 g/HP-hour on both NSJB and Farmington RMP sources would not be adequate alone to assure cumulative visibility impacts would be less than the NPS and FS visibility "Limit of Acceptable Change."

Table 3–215 Maximum Potential Cumulative Air Quality Impacts by Management Alternative (including reasonably foreseeable Colorado, New Mexico, SUIT, and Farmington RMP emission sources with well-head engines operating at a 9.6 g/HP-hour NOx emission rate)

PSD Class I Area	Pollutant	Units	Alternative 1	Alternative 2	Alternative 5	Impact Threshold
Mesa Verde	Nitrogen Dioxide	Annual (μg/m^3)	0.51	0.57	0.49	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.22	0.22	0.21	3
	Visibility	Greater than 1.0 deciview (days/year)	36 to 61	36 to 62	34 to 59	More than 1 day/year
Weminuche	Nitrogen Dioxide	Annual (μg/m^3)	0.27	0.33	0.21	2.5
	Atmospheric Deposition	Total Nitrogen Deposition (kg/ha-yr)	0.14	0.18	0.14	3
	Upper Grizzly Lake Chemistry[1]	ANC Change (percent)	8.1	8.6	7.6	10
		ANC Change (μeq/L)	2.0	2.1	1.9	1.0
	Visibility	Greater than 1.0 deciview (days/year)	22 to 43	24 to 47	15 to 38	More than 1 day/year

Note:
1. Potential cumulative impacts at other sensitive lakes would be less.
Source: RTP Environmental 2004

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